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STUDIES ON THE LIFE HISTORY OF NON-CAVE-DWELLING BATS IN NORTHEASTERN OHIO[1]

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Obtaining a few live, normal bats at different seasons for ovarian studies proved a difficult problem in northeastern Ohio. Bats were not abundant and were widely scattered in attics, barns, sheds and trees. Observations were continued since little was known about non-cave-dwelling bats and marked differences from cave-dwelling populations were found. This paper is concerned with observations on the life history of non-cave-dwelling bats in northeastern Ohio.

METHODS

With the aid of students and with a newspaper and radio request, attempts were made to locate bat sources in this area. The response and cooperation obtained have been excellent although the purpose of the investigation was often misunderstood at first. This study was often considered either a providential opportunity for the eradication of bats or an opportunity to find out if there actually were bats in an attic which the owner hesitated to enter. Work was hindered by baseless superstitions about bedbugs, lice, pinworms, hydrophobia, blindness, etc., which were more widespread than facts. These misconceptions were an understandable result of the scarcity, inaccessibility, and lack of information on bats. Practically no one had ever seen a live bat close enough to see its eyes or toenails. Reports of bats in 94 localities situated in 11 counties at distances of 3–80 miles from Kent have been investigated. Much interest has been shown and many helpful observations, which would have been impossible to obtain in any other way, have been made by the owners of the places where bats were found. In only a few cases were the superstitious fears so strong that the bats were removed.

The most frequent collections were made at the Gore's farmhouse, several miles from Burton, and at the Wayland Community Churches where the bats were the most numerous and accessible. In five years 52 trips have been made to the attic of the Gore's farmhouse and 23 to the attics in Wayland. From 2 to 10 trips have been made to a dozen other localities where collections were possible. An effort was made to collect on approximately the same date in successive years. In order to disturb the bats as little as possible, lights were kept low, loud noises were avoided and the bats handled gently with bare hands. On a few occasions bats were captured with nets or with Scudder intestinal forceps with which it is possible to get bats out of cracks without apparent injury to the animal. The bats were never stored before banding and were released at the earliest possible

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moment. Weighing was done to the nearest tenth of a gram with a spring balance designed especially for these bats. The animals were banded with No. 0 bands supplied by the U.S. Fish and Wildlife Service. Bands were placed on different legs and wings (Trapido and Crowe, 1946) so that the year of banding could be distinguished at a glance. All banding was done by the writer. But a number of children won the privilege of keeping baby bats warm while the mother bats were banded. Many of the bats were fed pablum, milk, insects and vitamin-mineral concentrates by pipette before release. A thermometer recording the maximum and minimum temperatures reached since the previous observation has been kept in the Gore's attic for three years and another for briefer periods at Wayland.

The terms "repeat," "return." and "recovery" are used in the same sense as is done in bird banding. A "repeat" is a banded animal recaptured during the same season in the same place; a "return" is an animal recaptured in the same place during a subsequent season; a "recovery" is an animal recaptured at another locality.

OBSERVATIONS AND DISCUSSION

The bats examined during five years are listed in table 1. These include animals used as experimental material, specimens brought in by school children, animals caught by pets, etc., as well as specimens obtained in regular collections.

TABLE 1

Bats captured in Northeastern Ohio

Species	Adults		Young		Total
	Male	Female	Male	Female	
Myotis l. lucifugus	37	1854	509	741	3141
Eptesicus f. fuscus	14	10	6	4	34
Lasiurus b. borealis		1		1	2
Lasiurus cinereus		1			1
					3178

Myotis l. lucifugus, the little brown bat, seems to be the common bat of the area; *Eptesicus fuscus*, the big brown bat, is uncommon; the two species of *Lasiurus*, the red bat and the hoary bat, are found rarely. This differs from the relative frequency of skins in the Cleveland Museum of Natural Hostory (Bole and Moulthrop, 1942) in which *Eptesicus fuscus* is the most abundant. This difference may be attributed to the large size of the bat and to the fact that *Eptesicus* also winters in this area and often enters buildings from which it is more likely to be brought to the attention of the museum staff.

One group of 8 lactating *Eptesicus fuscus* females with 6 young males and 4 young females was found in July 1950. Unfortunately, the shed in which they were living was remodelled within a few weeks. None of these animals or any other banded *Eptesicus* have been recaptured. The other individuals were brought in singly after they took shelter in houses, usually during the winter months. One adult female *Lasiurus borealis* was found at Pricetown on June 1, 1949, and a young female in Kent on July 28, 1952. One female *Lasiurus cinereus* was captured at Aurora on July 25, 1950. The remainder of this paper concerns *Myotis l. lucifugus*.

HABITAT

The little brown bats were found singly or in small groups in attics, barns, sheds, and trees. No large groups of a thousand or more such as were reported in a

Cincinnati home (Johnson, 1952) or in the Main Building on the campus at Carbondale, Illinois (Cagle and Cockrum, 1943) have been discovered. In 55 out of 94 localities one or more bats were found after one or more trips. Some of the remaining 39 places had mice, squirrels, or birds, but in at least 20 of these cases the descriptions of the owners clearly indicated that a bat had been present previously. The collections in which bats were found in places in which more than a single bat was ever obtained are listed in table 2. Seven roosts with as many as 200 bats at the peak of abundance have been found, but two have been destroyed with the remodelling of the buildings. There were 16 known roosts of less than a hundred but more than a dozen bats. Of these groups 7 have been destroyed by remodelling or fire.

With the exception of a few places, the probability of obtaining bats was not great. The mean number of bats obtained from collections in this area was 10.7. On more than half of the trips no bats were obtained so that both the median and mode were zero. If any bats were found the most common frequency was one. In such cases the characteristic guano deposit marking occupancy of long duration was not present. About a third of the localities in which a single bat was obtained, have been discovered at the start of insulating or remodelling procedures.

Even if bats are present collections are difficult or impossible in many places. As Griffin (1940) reported, favored locations are the rafter spaces within the roof overhang at the gables of frame houses. There may be more than a dozen exits from a single attic, of which several were used at one time and different ones at other times. Bats have also been found between the double walls of houses, within unused chimneys, in window frames, and hanging in crevices near the roofs of abandoned dog houses and huge barns. In only two cases have bats been found in attics used for storage although some remained in a large barn converted to a dance hall. A wrecking bar would be the most useful collecting tool, but it has limited applicability.

Wide ranges of light and temperature were observed in the roosts. Gore's attic has large windows in three of its four gables. Bats have been observed hanging on rafters in light with an intensity of 5–10 footcandles. At the other extreme is the attic at Berlin Reservoir which has no windows and where the amount of light was too small to be recorded. Temperatures have ranged from 45° to 116° F.

In any attic a particular arrangement of bats clustered in a certain area has never been observed in a subsequent collection. For several seasons maps were made of the Gore's attic at each collection showing where the bats were hanging by numbering the rafters in each gable. Neither duplication nor any pattern could be observed. With relatively few bats in a large attic the possible arrangements would be very numerous. For the last few years there have been fewer bats near the ridge of the roof where collecting is comparatively easy and more bats near the eaves where it is necessary to crawl prone over the rafters without falling through the plaster. On one occasion the bats were not disturbed except for a brief flash of light so that a rough map could be sketched. The next observation three days later, showed no similarity in arrangement. Ear bands, on which the numbers can be read without disturbing the bats, would not be particularly helpful in this area since it is difficult to see into many of the crevices and these non-hibernating bats move after a brief exposure to light.

At Wayland on one occasion the bats were captured singly by feel, banded in the lower attic level and returned to the same position within five minutes. The next week not a single one of the banded bats was recaptured anywhere and a single bat was in the crevice from which 15 bats had been obtained the week before. The attics of the two churches at Wayland, which are located within a 100 yards of each other, are considered together. The random movements between the two are like the random movements within a single attic. Of the bats obtained

TABLE 2

Collections of Myotis lucifugus lucifugus

Collection	Population	Bats Examined				Bats banded	Bats previously banded, total	Recaptures	Previously banded bats recaptured %	Recaptures in population %	Banded bats recaptured by end of 1952, No.	Banded bats recaptured by end of 1952, %
		Adult		Young								
		Male	Female	Male	Female							
Gore Farm, 1948												
4/15	1		1			1	31				1	100.0
4/22	30		19			15	32				13	86.5
4/29	80		63			59	47	1	2.1	1.3	22	37.4
5/13	75		62			32	106				11	34.2
5/27	85		8			18	138	10	7.2	11.7	10	55.5
6/3	110		28			15	156	11	7.0	10.0	9	60.0
6/10	125		19			10	171	7	4.1	5.6	5	50.0
6/15	140		13		5	5	181	11	6.1	7.9	1	20.0
6/23	150		32	4	6	24	186	6	3.2	4.0	11	45.8
6/29	150		21	9	15	7	210	11	5.2	7.3	3	43.0
7/13	160		66	29	33	16	217	5	2.3	3.1	4	25.0
7/27	140		20	9	13	29	233	5	2.1	3.6	4	13.8
8/10	50		11	11	13	13	262	8	3.0	15.9	2	15.4
8/23	30		6	4	2	8	275	4	1.5	13.3	1	12.5
9/15	35		6	7	19		283					
10/10	0						283					
Gore Farm, 1949												
4/13	2		2			1	283	1	3.5	50.0	1	100.0
4/20	2		2			2	284					
4/27	30		4			3	286	1	3.5	3.3	1	33.3
5/9	6		3				289	3	1.0	50.0		
5/25	2		2				289					
6/6	70		33			28	289	5	1.7	7.1	9	32.1
6/14	80		31	14	10	16	317	6	1.9	7.5	2	12.5
6/21	100		13	10	7	11	333	3	0.9	3.0	1	9.1
7/7	100		15	18	14	45	344	3	0.9	3.0	2	4.4
7/19	75		12	9	13	30	389	5	1.3	6.7	1	3.3
8/4	50		3	7	9	22	419	2	0.5	4.0	1	4.5
Gore Farm, 1950												
4/26	12		7				441					
5/15	20		13			6	441	2	0.5	10.0	1	16.7
6/15	45						447					
7/21	25						447					
Gore Farm, 1951												
4/19	4		4	.....			447					
5/10	20	1	10			9	447				1	11.1
7/13	80		29	26	22	69	456	9	2.0	11.2	3	4.4
7/26	35		5	5	6	14	525	2	0.4	5.7		
8/15	15		3	2	2	5	539	2	0.4	13.3		
Gore Farm, 1952												
4/17							544					
4/25	10		5				544	1	0.2	10.0		
5/16	40		8			13	544	3	0.6	7.5		
5/29	20		8			3	557	1	0.2	5.0		
6/20	70		20	24	8	41	560	7	1.3	10.0	4	9.8
6/26	30		6	10	7	16	601	5	0.8	16.6	1	6.3
7/17	40		6	6	6		617	4	0.6	10.		
8/8	25		2	4		5	617	1	0.2	4.0		
9/2	25		4	4	7	12	622	3	0.5	12.0		
9/17	6			2		2	634					
Wayland, 1948												
8/9	70		17	21	27	65						
9/15	6			1	2	3	65					

Table 2—*continued*

Collection	Population	Bats Examined				Bats banded	Bats previously banded, total	Recaptures	Previously banded bats recaptured %	Recaptures in population %	Banded bats recaptured by end of 1952, No.	Banded bats recaptured by end of 1952, %
		Adult		Young								
		Male	Female	Male	Female							
Wayland, 1949												
5/18	150	2	28			10	68				3	30.0
6/1	150	3	19			21	78	1	1.3	0.7	6	28.6
8/30	10			1	3	4	99					
Wayland, 1950												
7/19	100		40	16	14	34	103	1	1.0	1.0	5	14.7
Wayland, 1951												
5/17	80	1	65			63	137	1	0.7	1.2	22	35.0
6/7	200	5	133			68	200	6	3.0	3.0	14	20.6
6/27	200		3	4			268	3	1.1	1.5		
7/26	150		24	21	32	58	268	4	1.5	2.7	3	5.2
8,8	40		6	2	3	6	326	1	.04	2.5	1	16.7
8/22	60		15	1	24	34	332	1	0.3	1.7	5	14.7
8/31	35		5	7	13	15	366	1	0.3	2.9		
Wayland, 1952												
5/9	50		23			23	381	8	2.1	16.0	5	21.7
5 23	70		45			39	404	1	0.3	1.4	5	12.8
6/6	90	2	61			50	443	10	2.2	11.1	6	12.0
6,24	160		61	26	20	80	493	8	1.6	5.0	10	12.5
6/30	220		111	45	48	75	573	19	3.3	8.7	8	10.6
7/29	150		8	17	14		648	5	0.8	3.3		
9/3	90	1	23	9	44	46	648	26	4.0	28.6	2	4.4
9/8	70		18	7	33	48	694	10	1.4	14.3		
Berlin Reservoir; 1949												
7/30	60		20	17	18	48					2	4.2
Berlin Reservoir, 1951												
5/24	40	2	38			33	48	2	4.6	5.0	4	12.1
6/7	40	6	8			12	81	1	1.2	2.5	1	8.3
Berlin Reservoir, 1952												
6/6	35	1	13			8	93	2	2.1	5.7		
7/29	25		9		1		101	2	2.0	8.0		
9/15	6	1	1	2	1	3	101	1	1.0	16.6		
Twinsburg, 1948												
9/15	6		1	1	2	4						
Twinsburg, 1949												
6/30	18		10	3	4	17	4					
8/4	20		10	1	8	19	21					
Pricetown, 1949												
6/1	60	3	23			26					3	11.5
7/5	150		26	19	15	53	26	1	3.8	0.7		
7/12	150		22	13	8	30	79	1	1.3	0.7		
8/30	25		8	3	13	17	109	1	0.9	4.0		
Pricetown, 1951												
6/7	40	3	3			5	126					
Pricetown, 1952												
6/6	50	5	3			6	131					
Rex Lake, 1948												
9/16	3			1	2	3						
Rex Lake, 1949												
8/8	50		21	4	31	24	3				1	4.2

Table 2—*continued*

Collection	Population	Bats Examined: Adult Male	Adult Female	Young Male	Young Female	Bats banded	Bats previously banded, total	Recaptures	Previously banded bats recaptured %	Recaptures in population %	Banded bats recaptured by end of 1952, No.	Banded bats recaptured by end of 1952, %
Rex Lake, 1951												
4/26	20		7			0	27	1	3.7	5.0		
Painesville, 1951												
7/13	100		16	1	8	8						
8/15	75		20	8	33	50	8				1	
Geauga Lake, 1951												
7/4			10	1	1							
Lake Milton, 1951												
7/6	50		32			32						
St. Joseph, 1951												
8/31	50		16	5	20	37					3	8.1
St. Joseph, 1952												
9/15	6	1	2		3	3	37	1	2.7	16.6		
Deerfield, 1952												
8/18	40		7	10	15	34						
9/3	8		3	1	1	5	34					
North Benton, 1952												
7/29	100		36	19	24							
Other non-cave-dwelling populations in Ohio												
Wilmington, 1948												
7/17	50		10	22	10	34					2	5.9
Wilmington, 1950												
7/24	50		11	13	21	45	34					
Put-in-Bay, 1952												
8/16	100		42	19	28	78						
Nearest cave populations												
Uniontown, Pennsylvania, 1951												
3/10	80	65	14									
Uniontown, Pennsylvania, 1952												
5/3	160	151	8			144						
Harlandsburg, Pennsylvania, 1950												
10/29	30	24	5			28						

in Wayland over three-fourths have been found in the one used as a parish house. But almost the same proportion of bats banded in the other church have been recaptured in the parish house. Random movements of bats from place to place was also observed in the huge attic in southern Illinois (Cagle and Cockrum, 1943) and to a lesser extent in caves (Guthrie, 1933; Mohr, 1952) but not in the apparently crowded tree roost observed in Chicago (Dubkin, 1952).

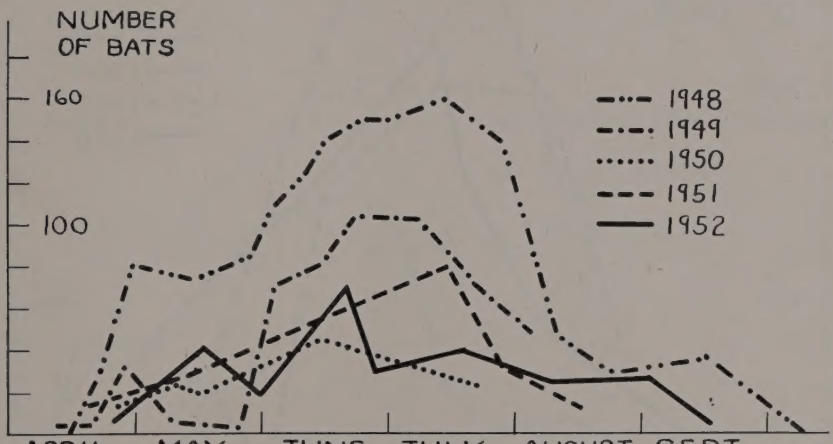
SEASONAL DISTRIBUTION

Bats are summer residents in this area. In different years the capture of the first arrivals in the spring has varied from April 10 to April 26. No correlation could be observed between the mildness of the spring and the time of arrival of the

bats. The number of bats reaches a maximum in June and July when parturition and lactation occur. Parturition extends from June 10 to July 17. By the middle of September only a few bats will be found in a given locality. Between September 22 and October 17 all of the bats have departed. There are no records for the last half of October or November, but two bats were observed on December 2, 1948. The location of the bats during the winter is not yet known although caves in Pennsylvania, West Virginia, Kentucky and Tennessee have been searched without success in recapturing any of the bats banded in this study.

POPULATION TURNOVER

The total numbers at a roost vary with the particular roost, the year and the season (table 2) although all of the roosts studied show a peak in June and July. The population at Gore's farm are plotted in figure 1 and at Wayland in figure 2. The marked scarcity of bats at Gore's farm during May, 1949, and July, 1952,



BAT POPULATION IN ATTIC OF GORE'S FARM

FIGURE 1

was checked by the owners between collections. The eccentric roosting behavior in northeastern Ohio is in marked contrast to the comparative stability of cave populations (Guthrie, 1933; Guthrie, Jeffers, and Smith, 1951). The reservior of bats banded previously at Gore's farm in 1948 is plotted against the total population and the repeats in each collection in figure 3. The repeats were not proportional either to the total population or to the number of bats previously banded. Similar results were obtained in other years and in other attics.

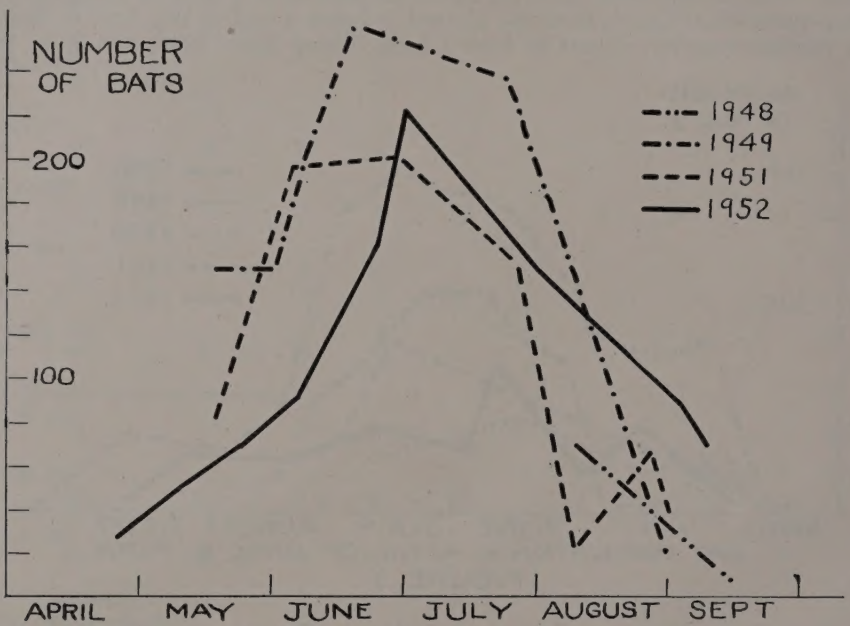
The ninth column in table 2 gives the number of bats previously banded at a particular locality that were captured in a given collection. The tenth column gives the percentage. Various possible explanations of the low recapture rate in individual collections were examined: (1) failure to capture bats that were actually present, (2) shifts to other roosts, (3) high mortality rates, (4) population spread out over a wide area.

(*1*) *Failure to capture bats that were actually present.* This possibility was the most obvious. In no locality is it possible to collect every bat. In three collections strenuous efforts were made to check every crevice in the Gore's attic. From 1 to 5 additional bats, none of which happened to be banded, were collected. A few bats usually leave the attic at the first disturbance and can not be collected. Even with great care all of the hiding places could not be detected, for several

bats emerged from the attic during the evenings after the special searches. Larger numbers were undoubtedly missed in other localities where collecting was more difficult. Although no collections were complete, the numbers missed were not adequate to account for the low recapture rate.

(*2*) *Shifts to other roosts.* No shifts from one roost to another have been observed. If bats are recaptured at all, they are captured at the place banded.

(*3*) *High mortality rate.* Few dead bats have been observed. About two dozen baby bats were found on the floors of roosts and half a dozen killed by household pets. In spite of the hazards of increasing age there is a definite tendency for a bat to return to its particular roost eventually. The figures for individual collections are given in the last three columns of table 2. The last



BAT POPULATIONS IN WAYLAND
FIGURE 2

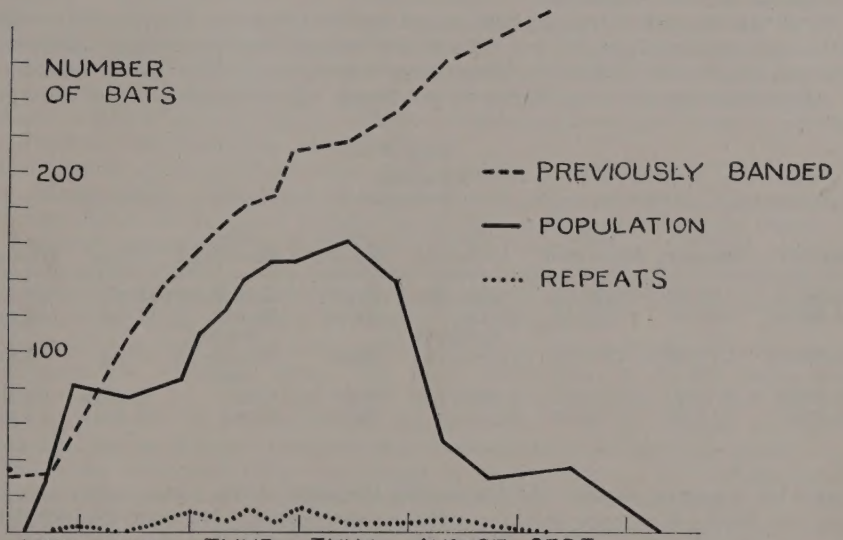
column gives the percentage of the bats banded in a given collection that have been recaptured at any time up to the end of 1952. In general more bats have been recaptured from the earlier collections.

(*4*) *Population spread out over a wide area.* A small but variable percentage of the population is at the roost at any given time. A particular bat does not remain long at the roost which seems to serve as the headquarters for an area. The scarcity of large roosts, the low recapture rate (table 2, column 10) and the large number of bats caught singly in locations without evidence of long occupancy suggest that the bats are spread out singly or in small groups over a wide area when they are not in the headquarters roost. In three cases, careful observers have reported that a single bat, which may have been the one subsequently collected, was seen at dusk several days before capture. The places where bats were found singly often seemed to be temporary shelters where collection was merely fortuitous. In half a dozen places where a single bat was obtained, examination in subsequent weeks and subsequent seasons showed no evidence of the

presence of another bat. Since recapture rate at a roost depends both on population turnover and mortality rate, it is difficult to estimate the relative importance of those factors. At Gore's farm more bats were recaptured for the first time during both the fourth and fifth seasons after banding than in the third season after banding.

HOMING EXPERIMENTS

The high population turnover at the roosts was reflected in the results obtained with homing experiments. Although a bat may have returned to a given area it was not likely to have been recaptured unless it came to the roost. Of 1855 banded bats, 519 were released at distances of 6 to 49 miles from the place captured in 24 different experiments and 1336 were released where captured. Only 34 (6.5%) of



BATS RECAPTURED AT GORE'S FARM 1948
FIGURE 3

those released elsewhere were recaptured; 191 (14.3%) of those released at the same place were recaptured. Furthermore, 25 of the 26 animals captured more than once had always been released at the place where originally captured. This behavior differs from that observed by Griffin (1940) and Hitchcock and Reynolds (1942) which indicated a higher percentage of returns from bats carried away from the roost than from bats released at the roost. In this area bats seemed more disturbed the longer the duration of the interference with their normal behavior.

None of the bats rushed back to the roost after release at a distance. Only 8 were repe the other 26 were recaptured in subsequent years. The greatest distance overed by 2 bats which returned 228 miles to Wilmington but which were not recovered until the second season after release (Smith and Hale, 1953). The best time observed was in one bat which returned 25 miles in two weeks. In 10 of the experiments the bats were released at the writer's home in Akron. In 9 of those cases banded bats were observed flying the next evening. In each case from 1 to 3 banded bats were brought in by neighbors up to a week after the bats had been originally released. In individual experiments the recapture rate varied

from 0 to 26.6 percent. With the relatively short distances used neither the distance from the roost nor the direction seemed to affect the recapture rate.

RECOVERIES

No spontaneous shifts of bats from one roost to another have been observed over a period of 5 years. If bats reappeared in this region, they went to the same roost where they were originally banded. Over 300 bats from Wilmington, Put-in-Bay, and Dulaney's cave near Uniontown, Pennsylvania, have been released at Gore's farm and at Wayland, but none of these bats from other areas to the south, west and east have been recaptured where released. Apparently bats do not remain in a strange roost. Griffin (1945) observed three cases of bats banded on Cape Cod and recovered in later seasons each at a different roost in other parts of New England.

All of the recoveries, that is, bats recaptured at any place except where originally found, are listed in table 3. All were individuals used in homing experiments. Two had unfortunate home conditions; one was a female less than a month old; the others were merely in no hurry to get home. In 2 localities there were good

TABLE 3

Recoveries

Number	Date Banded	Date Recovered	Place Collected	Place Released	Place Recovered	Time	Distance
20–64774	7/13/51	6/20/52	Painesville	Kent	Gore Farm	11 mo.	20 mi.
48–69708	5/24/51	7/21/52	Berlin Reservoir	Akron	North Benton	14 mo.	28 mi.
48–69541	7/ 5/49	7/ ?/52	Pricetown	Kent	Rootstown Center	3 yrs.	6 mi.
20–64866	8/15/51	8/17/51	Painesville	Kent	Kent	2 days	½ mi.
20–66161	5/ 9/52	5/16/52	Wayland	Akron	Akron	7 days	4 mi.

reasons for changing roosts. At Painesville the shed at the water works was torn down; at Berlin Reservior sulfur candles were burned. Number 48–69708 had been recaptured previously at Berlin Reservior after being released in Akron. After its second release in Akron it was recaptured near North Benton, the nearest known roost, only about 2 miles from Berlin Reservior. Unfortunately this experienced animal was killed when captured.

Number 48–69541 had nearly reached adult weight although less than a month old when banded. She was captured at Pricetown, released at Kent, and recaptured at Rootstown Center. The distance from Kent to Rootstown is six miles, to Pricetown thirty miles. It is remarkable that such an inexperienced female survived even though confused. The other recoveries are bats that were loitering on the way home. One in Akron, had gone four miles in the wrong direction in seven days.

SENSITIVITY TO DISTURBANCE

Bats are sensitive to disturbance and handling as is shown by weight loss after banding, decrease in numbers in bat populations studied and low recapture rate of banded animals. Some weight loss occurs immediately after capture. On May 3, 1952 male bats were measured and banded at Dulaney's cave near Uniontown, Pa. between 6:00 and 8:00 P.M. The bats were transferred in cages covered with wet burlap in the trunk of a car. The trunk temperature was within 10° of the cave temperature. The bats were weighed 8 hours later in Kent before being released. The mean weight and the standard deviation of the mean of 60 male

bats when banded was 5.76 ± 0.35 gr. The weight loss in 8 hours was 0.42 ± 0.18 gr. This is an average of 7.3 percent. The maximum loss was 12.5 percent. The minimum loss was 1.8 percent. A single bat is recorded as gaining 1.8 percent which may be attributed to a personal error at the end of 25 hours of continuous activity.

The period of weight loss lasted at least 3 weeks. Sixteen bats were recaptured within 3 weeks of banding, excluding those that gave birth to young in the interval. All were females. Weight gains were shown only during the middle of pregnancy in late May and June and in each case the weight was less than the mean weight of the collection. Weight losses occurred at other seasons even during August and September when fat storage usually occurs. Bat 20–64510 was banded on May 17, 1951 then recaptured on August 8 and August 22 of the same year. By August the apparent traumatic effect of banding had disappeared and the bat gained weight in the 2 week interval between its second and third recapture. One bat recaptured 4 weeks after banding had barely regained its weight at banding. Two bats recaptured after 5 weeks showed weight gains. More than half of the bats were fed before release. Not enough repeats are available at comparable seasons to determine whether feeding had any effect on reducing the weight losses or whether the additional handling was undesirable.

The bats in summer roosts were more sensitive to disturbance than those in caves (Mohr, 1952). The effect of frequent collections, no matter how carefully done, was shown in the total population of Gore's attic over 5 years (figure 1). The numbers dropped during the second year and were so low the third year that visits were discontinued. The fourth and fifth years the numbers increased but did not reach the level of the first two years. At Wayland (figure 2) where fewer collections were made the effect was much less pronounced.

Similarly, the date of the first arrival seemed correlated with the amount of disturbance the previous year. The first specimens at Gore's farm were obtained on April 15, 1948, and April 13, 1949, but in 1950 and 1952 no bats arrived until April 26 and April 25, respectively. The percentage of banded returns also seems related to the amount of disturbance the previous year.

The future of bats in Ohio is a matter of some concern. The extermination in Cincinnati of more bats than have been found in all of northeastern Ohio (Johnson, 1952) is a discouraging indication of a common attitude toward these useful animals. No new large roosts have been discovered in the last two years. After the destruction of roosts by remodelling or fire the location of the bats is not known. Only one bat has been recovered at any other roost. Although shooting bats is indeed a test of skill, it is not a sport to be encouraged. Fortunately bats are clever at choosing crevices where capture is often difficult or impossible. Data are not yet adequate for determining population trends in this area, but the data do indicate that bats are sensitive to any sort of disturbance and that the greater the disturbance the lower the recapture rate.

SUMMARY AND CONCLUSIONS

1. The non-cave-dwelling bats of northeastern Ohio were studied from 1948 to 1952 in a total of 94 localities in 11 counties.

2. Four species were collected: *Myotis l. lucifugus* was the only common species. They were summer residents. 1855 were banded; 225 were recaptured. *Eptesicus fuscus* was uncommon. 24 were banded after capture throughout the year. None were recaptured. *Lasiurus b. borealis* and *Lasiurus cinereus* were rare.

3. The principal habitats of *Myotis l. lucifugus* were attics, barns, sheds and trees. No definite spatial arrangement of roosting bats could be observed in any habitat. The population peak was reached in June and July, but the roosting behavior was erratic. The low recapture rates were attributed to the scattering of the bats singly or in small groups over a wide area.

4. Bats showed some homing behavior, but return to the roosts was very slow. At distances of less than 50 miles neither the time of year, the distance, nor the direction affected the recapture rate. There were no shifts from one roost to another. Of the banded bats, 14.3 percent of those released at the roost were recaptured and 6.5 percent of those released elsewhere were recaptured.

5. Weight loss began immediately after banding and lasted about a month. Bats lost 7.3 percent of their weight within 8 hours after banding. Weight losses were observed during 3 week intervals after banding, but gains were recorded after 5 weeks.

6. The greater the disturbance of the bats at a roost the fewer were recaptured in the following weeks or the following year.

ACKNOWLEDGMENTS

The writer is much indebted to a great many people who have assisted in this study in one way or another but especially to Mr. and Mrs. Leland Gore, the trustees and members of the Wayland Community Church, Mrs. R. T. Shinn, Mrs. F. F. Bourne, Mr. C. F. Wallace and Mr. Hugh Smith for assistance over several years. My thanks also go to the owners of the 94 properties, which were investigated, for their cooperation. Part of this work was aided by a grant from The Ohio Academy of Science.

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Morphogenesis in Plants. *C. W. Wardlaw.* John Wiley & Sons, Inc., New York. 1952. xv+176 pp. $2.25.

The achievements and unsolved problems of the morphogeneticist are discussed by a leader in the field of experimental plant anatomy. Problems such as the time, place and mode of initiation, as well as vascularization, and the attainment of form of leaves, roots, shoots and floral parts are discussed in relation to specific physical, physiological and genetic factors. The underlying basis for the discussion of each topic is the result of direct experimentation rather than hypothesis, or theory. In each case the source of the experimental evidence is cited in an extensive bibliography. The book summarizes, correlates and evaluates much of the important work thus far accomplished in the field of direct experimental plant anatomy.

R. A. Popham

TWO NEW UNIQUE SPECIES OF ALCONEURA FROM MEXICO
(HOMOPTERA: CICADELLIDAE)

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These two species of Alconeura resemble the typical species of the genus in wing venation, body shape, and general appearance, but they are easily differentiated from the others by their unique male genital structures. In both species the pygofers are long and pointed at their apices, the pygofer hooks are long and curved mesad, the plates are slender deeply notched and toothed on the middle of their lateral margins, the shafts of the styles are long with their preapical lobes narrow, the dorsal processes of the aedeagus are fused to the phalicata, and the phalicata is recurved.

The types of these species are in the DeLong collection.

Alconeura rossi n. sp.

Resembling *albavulta* Ruppel and DeLong in general form and appearance, but with distinctive coloration and genitalia. Length 2.8 mm.

Vertex is produced for about one-half of its length in front of the eyes, its anterior margin rounded, and its median length equal to its basal width between the eyes; the posterior margin of the pronotum noticeably concave.

Color: The vertex is cream with its lateral margins ivory and with a pair of median, orange-tan lines extending from its apex to its posterior margin. The face is ivory with its dorsal portion cream. The pronotum is cream with its disk, a few spots along its anterior margin, and a pair of lateral, longitudinal, irregular stripes, orange-tan. The scutellum is cream with its basal angles, apex, and a pair of small spots on its disk, orange-tan. The elytra are golden with their apical cells hyaline and with a small, black spot in the basal corner of the posterior apical cell.

Genitalia: The pygofer hooks arise on the dorso-caudal angle of the pygofers, are broad at their bases, taper evenly to sharply-pointed apices, and curve mesad for their entire length. The base of the aedeagus bears a pair of short, straight, ventral processes and a pair of short, lateral processes are closely appressed to the apex of the phalicata.

Holotype male and male paratypes collected at Iguala, G'ro., Oct. 25, 1941 by DeLong, Good, Caldwell, and Plummer.

Named for Dr. Herbert H. Ross for his fine work in the Taxonomy of many groups and especially for his present work in the Erythroneura of Mexico.

Alconeura sigmaforma n. sp.

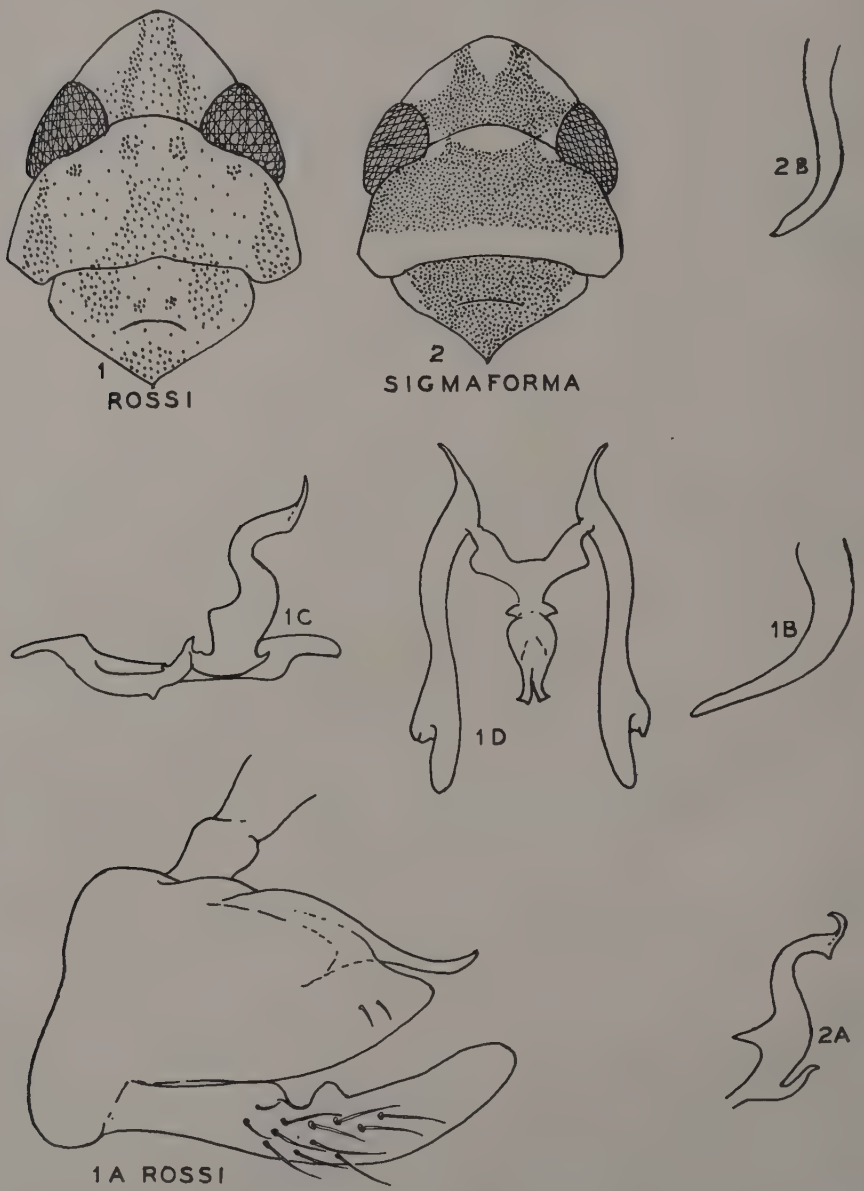
Resembling *rossi* in general form and appearance but with the vertex shorter and with distinctive coloration and genitalia. Length 2.6 mm.

Color: The vertex is dull red with its lateral margins, a median spot at its apex, and a spot next each eye ivory. The face is tan with its dorsal portion, genae, lorae and a median, longitudinal line ivory. The pronotum is dull red with the central portion of its anterior margin cream and its posterior margin broadly bordered with ivory. The scutellum is dull red with its margins finely bordered with cream. The elytra are translucent white with the veins of the apical cells embrowned and with a round, black spot in the basal corner of the posterior apical cell. Each clavus is marked with three, transverse, red bands; a narrow band at its base a broad band across its center, and a broad band near its apex. A pair of anastomosing, large spots on the corium along the claval suture, a broad, transverse band across the corium just anterior to the transverse veins, and a broad bar extending from the middle of the costal margin to the center of each elytron are red.

Genitalia: The male genitalia of this species closely resemble those of *rossi*, but the pygofer

hooks are abruptly curved mesad near their apical third, the ventral processes of the aedeagus are longer and slightly recurved, and the apical processes of the phalicata thinner and curved.

Holotype male collected at Tetela del Rio, G'ro., Aug. 13, 1930 (MF 1767) by J. Parra; paratype male Yetla, G'ro., Aug. 11, 1930 (MF 1756) by J. Parra.



1. *Alconeura rossi*—head, pronotum, and scutellum; 1a—lateral view of male genital capsule; 1b—dorsal pygofer hook; 1c—lateral view of aedeagus and style; 1d—ventral view of styles and aedeagus. 2. *A. sigmaforma*—head, pronotum, and scutellum; 2a—lateral view of aedeagus; 2b—dorsal pygofer hook.

DERMATOGLYPHIC TRAITS OF JEWISH AND NON-JEWISH WHITES

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The systematic study of Dermatoglyphics has advanced through the researches of Wilder (1922), Montgomery (1926), Henry (1934) and Cummins (1926 and 1929). Application of this knowledge to Anthropological studies is on record by Biswas (1936), Cummins, Lane, Leche, Millar, Steggerda (1936), and Abel (1937). A comprehensive review of the methods and biology of Dermatoglyphics is given by Cummins and Midlo (1943). A revised method for plantar formulation developed under the direction of Professor Norma Ford Walker of the University of Toronto is employed in this analysis.

In the present report is presented a statistical analysis of palmar and plantar pattern frequencies of 309 Jewish people of Toronto and Chicago as compared with 124 non-Jewish Whites of the same areas.

Four main sources supplied the prints required: (1) students of the University of Toronto, (2) students of public schools and collegiates of Toronto, (3) members of the Young Men's Hebrew Association of Toronto, (4) students of the University of Chicago and members of Marcy Centre, Chicago. The second and third sources supplied prints of about 250 Jewish people and the fourth supplied prints of an additional 60 Jewish people.

The ancestry of the groups was as follows:

	Females	*Males*
Jewish with Polish ancestry	47	54
Jewish with Russian ancestry	41	32
Jewish with Russian-Polish ancestry	12	18
Jewish with Central European ancestry	12	16
Jewish with mixed European ancestry	18	24
Jewish with English ancestry	4	5
Jewish with North American ancestry	4	5
Jewish offspring of cousin marriages	6	11
Jewish total.....309:	144	165
Non-Jewish, English, Scottish, Irish	30	32
Non-Jewish, various nationalities	16	46
Non-Jewish total.....124:	46	78

REVISED METHOD OF PLANTAR FORMULATION

In this study special attention has been given to the formulation of the plantar configurations, which up to the present have not been described as satisfactorily as have the palmar patterns. All prints were made by the inkless Faurot method which makes possible the printing of the entire ridge skin area of the sole on a single sheet of sensitized paper by one rolling motion. A brief outline of the revised method of formulation is necessary.

Plantar topography and marginal loci numbers are given in figure I A. Main lines, Hal (E), A, B, C, D, are traced from their digital triradii to their marginal terminations. The locus of each termination is recorded. For example, main line B crossing the long axis of the sole obliquely may terminate at 15 (figure I, C.). When a main line becomes involved in the hallucal area it terminates as 15h.

Recurving main lines running into interdigital whorls or loops will not terminate marginally and are therefore formulated as interdigital, e.g., 9i or 11i.

Plantar hallucal configurations are formulated according to the method of Walker (1946) who gives a double formulation, descriptive of both the distal thenar and the first interdigital area (W^s/O, figure 1, C.). Whorls are of three types: concentric (W) spiral (W^s) and seamed whorls (W^{sm}). S-Patterns may occur. Central pockets (CP) are like whorls except that they have no confluent circular ridges. Loops open in three directions: tibial (L^t), fibular (L^f), and distal (L^d).

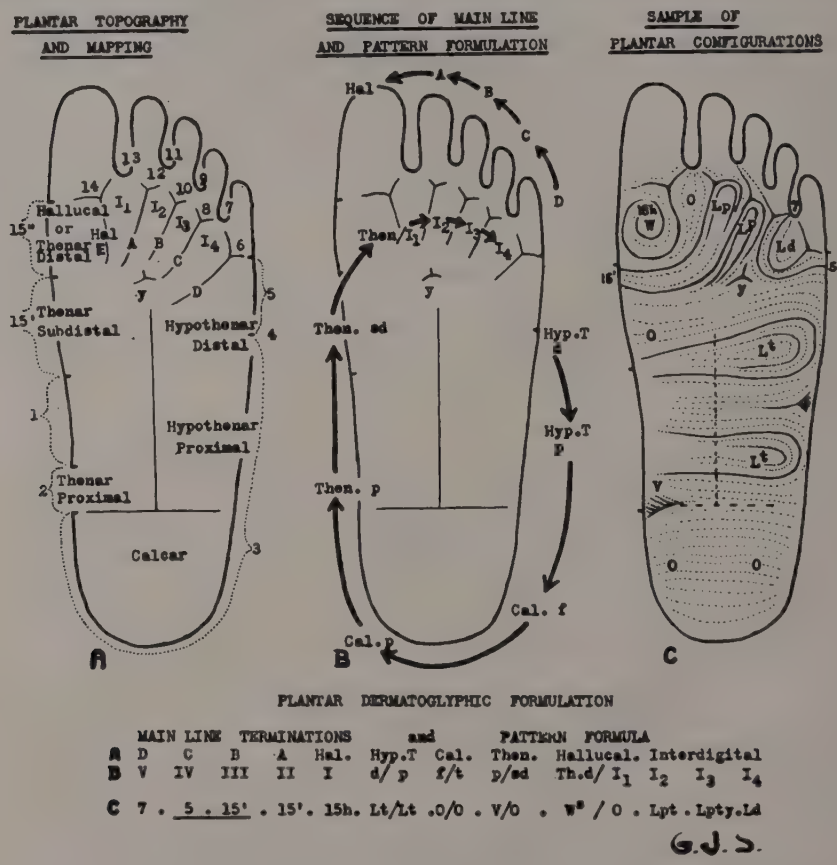

FIGURE 1. Plantar topography and dermatoglyphic formulation.

Arches open proximally (A^p), tibially (A^t), fibularly (A^f), and distally (A^d). Open fields (O) are common as part of the dual formulation.

Second, third and fourth interdigital areas show elongated whorls (W); loops distal (L^d), proximal (L^p), proximal opening fibularly (L^{pf}) and tibially (L^{pt}); loops accompanied by accessory triradii (D and d); vestiges (V), small vestiges (v); open fields (O), and multiplications (M). Proximal triradii are indicated as y, subordinate to a loop or whorl (figure 1 C, in the third interdigital note the pattern, $L^{pt}y$).

In the hypothenar, calcar and thenar areas dual formulations are the more

convenient. The hypothenar area is divisible into distal and proximal and each area may show a distinct loop usually opening tibially but sometimes fibularly (L^t/L^f). Arches (A), multiplications (M), or vestiges may also be present. The calcar area is formulated in dual fibio-tibial order. Tibial vestiges in the calcar and thenar proximal area are common. True calcar patterns are extremely rare. The calcar and sub-distal thenar are most commonly open fields, that is they have the lowest pattern intensity. Complete hypothenar and thenar formulations are an innovation in the present study. By printing onto the extralimital margins two distinct pattern areas may be discovered in the hypothenar region (figure 1, C. Lt/Lt).

TABLE 1

Plantar formulae for the 16 tracings of actual prints shown in figure 2.

Case No.	Linear Formula						Pattern Formula					
	D V	C IV	B III	A II	Hal I	Hyp. T d/p	Cal f/t	Then p/sd	Hallucal Th. d/I_1	Interdigital I_2	I_3	I_4
Left Plantar												
1A	15'	15'	15''	15''	15h	Lt/Lt	Lt/v	V/O	W/O	O	V	O
1B	13	*9i*	*7i*	*7*	15h	Lt/V	O/O	O/O	W/O	Lpy	W	Lp
1C	*15''*	*10*	*8*	*7i*	15h	Lt/O	O/O	O/O	W/O	Lpy	W	Lpt
1D	11i	9	*7*	*5*	15h	V/Lt	O/O	v/O	W/O	Lpy	Ld	Ldy
2A	15''	15h	13	11	9	O/O	O/O	O/O	Lfd/O	W	O	O
2B	15''	9i	*7*	*0*	15h	Ap/Lt	O/O	O/O	W/Oy	O	W	O
2C	11	9	7	5i	5i	Lt/O	O/V	O/O	O/Af	O	Ld	O
2D	15'	*0*	*7i*	*7i*	7i	Lt/O	O/O	O/O	Ap/O	Lpf	W	O
Right plantar												
3A	15''	13	*0*	*0*	7	Ap/Lft-Lt	O/v	O/O	O/Lf	O	Ld	O
3B	15'	11	9	7	13	Lt/V	O/O	O/O	O/Ldy	O	Ld	M
3C	15'	15h	15h	15h	15h	Lt/V	O/O	V/O	Ld/W	O	Ldy	O
3D	13	13	13	13	5	Ap/v	O/O	v/O	O/Ld	O	M	M
4A	15'	15'	15'	15''	15h	Lt/Lt	Lt/V	V/O	W/O	O	M	O
4B	15'	15'	*15''*	*15''*	13	Lt/O	O/O	V/O	O/Ld	Lpt	O	O
4C	15'	9	*7*	*7*	15''	Ap/Lpf	O/O	O/O	CP/Oy	Lp	Ld	O
4D	8	6	9	9	13	Lt/Lf	O/v	O/O	O/Ldy	O	Ldy	Ld

The numbers in Italics indicate the extent of digital derm ridge confluence distal to the digital triradii.

The order of complete plantar formulation is indicated in figure 1 B. It is as follows:

1) Terminations of main lines in the sequence, D, C, B, A, Hal (or E).
2) Hypothenar distal and proximal configurations.
3) Calcar fibular and tibial areas.
4) Thenar proximal and sub-distal areas.
5) Hallucal (distal thenar and first interdigital patterns).
6) Second interdigital (I_2) configurational area.
7) Third interdigital (I_3) configurational area.
8) Fourth interdigital (I_4) configurational area.
9) Ridge confluencies above digital triradii formulated by underscoring linear formula.

Figure 1 with its subscripts illustrates this complete formulation. Sixteen other sole tracings are shown in figure 2, and their formulations are presented in table 1.

TESTS OF SIGNIFICANCE

To determine the statistically significant associations of traits with either the Jews or the non-Jews the chi-square test is applied. Grouping configurations

TABLE 2

Comparison of the frequencies of the terminations of the palmar main lines in Jewish and Non-Jewish people. (Left and right combined. Jewish, 618 palms; Non-Jewish, 248 palms.)

Loci	Line D		Line C		Line B		Line A	
	Jewish	Non-J.	Jewish	Non-J.	Jewish	Non-J.	Jewish	Non-J.
1							2.6	6.1
2					0.2		4.4	2.0
3					0.3		29.6	*36.3*
4					0.6	0.4	15.5	16.9
5'			0.7	0.4	10.0	8.9	*40.5*	33.1
5''			8.7	11.3	31.4	*39.9*	5.2	4.0
6			2.8	3.2	7.6	7.7		
7	9.9	12.9	29.0	27.8	*42.6*	*39.9*		0.4
8	2.8	3.2			3.4	0.4		
9	29.8	*31.9*	*48.7*	*40.7*	3.1	2.4		
10	9.5	8.9	2.6	0.4				
11	*47.7*	*41.1*	0.5	1.2	0.2		2.3	1.2
13	0.3	0.4						
X			3.4	4.8	0.2			
X			1.1	4.0				
O		1.6	2.4	6.0	0.5	0.4		
Accessory Triradii	5.7	7.7	0.5	0.4			1.1	1.2
Chi-square for the entire range		9.949	*16.112*		9.459		*14.652*	
n equals		5	5		5		6	
Critical Significance value	11.070		11.070		11.070		12.592	
Association:	Not Significant		Significant		Not Significant		Significant	
Chi-square for Termination X			*6.128*					
for Absence of Line			*7.228* (Where n is 1, p 0.05, Crit. Val. 3.841) Both Significant					

Most frequent Main Line Terminations:
JEWISH: 11 . 9 . 7 . 5' — NON-JEWISH 11 . 9 . 7 . 3 —
or 9 . 7 . 5'' 5'

TABLE 3

Frequencies of positions of axial triradii of Jewish and Non-Jewish people determined by linear measurement and expressed in percent of total palm length. (By the method of Walker and Penrose.) (Left and right palms are combined.)

Position of Triradius*	Jewish (622 palms)	Non-Jewish (300 palms)	Chi-square value
0	1.9	0.0	
t	29.6	45.3	*22.157*
t'	59.6	51.0	*6.191*
t''	8.8	3.7	*7.510*
Two or more Triradii per palm	15.7	7.0	*13.802*

In all Chi-square tests, n is 1, for p 0.05 the Critical Value is 3.841, therefore all four values show Significant Associations.

* 0—absence of triradii; y, triradius within 0 to 14.9% of palm length from distal bracelet crease to proximal crease at base of third digit; t', 15 to 39.9%; t'', 40% and over.

dichotomously either as patterns or as pattern-less, a two by two (2 x 2) table enables us to use the standard formula:

$$X^2 = \frac{(ad - bc)^2 N}{(a + c)(b + d)(c + d)(a + b)}$$

Consulting Fisher's (1936) table for n equal to 1, and for the probability 0.05, chi square (X^2) should equal or exceed 3.841 to indicate a significant association between the two variables. In some tests a greater degree of freedom is found necessary, and two by n (2 x n) calculations are applied. Of the many traits involved in these computations only those configurations which show significant differences between Jews and non-Jews are pointed out.

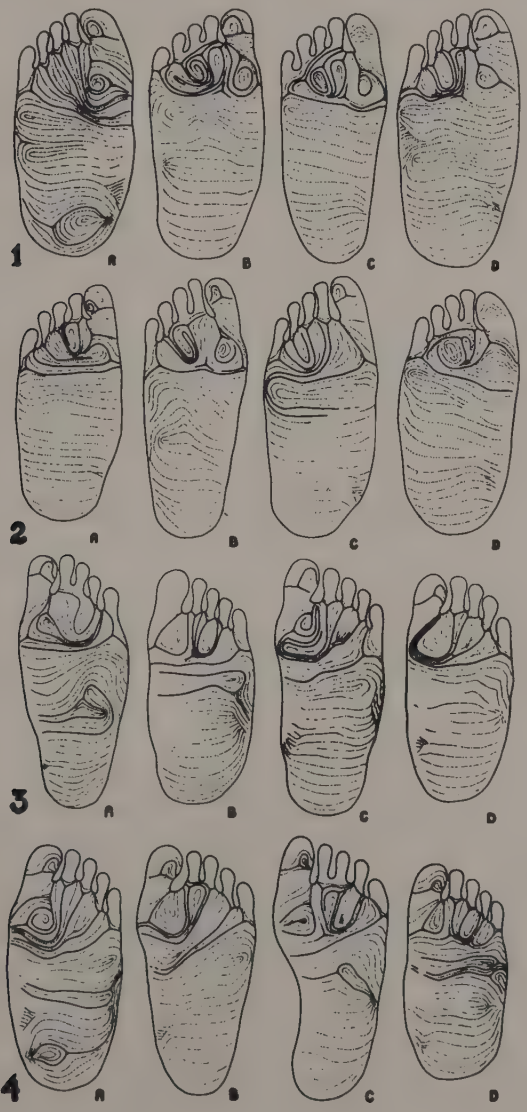

FIGURE 2. Tracings of plantar configurations from 16 rolled prints.

TABLE 4

Comparison of configuration frequencies in all palmar areas of Jews and Non-Jews. (Expressed in percentages based on 618 Jewish and 248 Non-Jewish palms.)*

PATTERNS	HYPOTHENAR		THENAR		I_1		I_2		I_3		I_4	
	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.
O	16.3	13.3	78.9	77.4	90.8	92.3	65.2	56.8	43.2	54.4	31.4	21.8
v & V	15.5	13.7	18.1	21.3	7.9	7.3	16.5	32.6	1.8	2.4	16.2	29.4
M			0.6	0.4	0.2	0.0	12.5	6.4	0.3	1.2	7.8	3.2
l and L	36.4	29.8	1.9	0.8	1.1	0.4	0.5	0.0	53.4	41.9	39.1	41.5
d & D							5.2	4.0	1.5	0.0	14.1	13.3
W	4.2	2.8	0.2		0.2				0.2			
S	2.3	2.8										
T	0.5	0.8										
Au	83.6	87.9										
Ac	41.2	49.6										
Ar	2.1	2.0										
P-th		1.2										

Chi-square tests dichotomously applied, grouping Patterns (T, l, L, d, D, W. S. P-th) and Patternless (O, v, V, M, A) so that n is 1, and Critical value is 3.841, p 0.05.

X^2	2.505	0.021 for thenar plus I_1	0.955	12.095 Association Significant	0.182

*Percentages exceed 100 in the totals due to dual configurations in some areas, especially the hypothenar.

TABLE 5

Comparison of frequencies of plantar main line terminations in Jews and Non-Jews expressed in percentages. (Based on 618 Jewish and 248 Non-Jewish soles.)

Locus	Line D.		Line C.		Line B.		Line A.		Line E, or Hallucal.	
	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.
5			0.8	0.8	1.3	4.0	1.9	2.4	1.7	2.1
6			0.3		1.1		0.6	0.4	0.2	0.4
7i			0.2		0.3		0.6		0.2	
7	2.7	4.8	2.6	2.4	15.5	*20.6*	13.3	14.1	4.5	4.4
8	0.3				6.5	4.4	3.1	2.0	0.2	0.4
9i	0.8	1.2	3.6	5.2	7.3	2.0	2.3	1.6	1.0	2.0
9	1.6	2.4	*24.7*	*31.9*	14.6	16.1	7.0	4.4	1.0	1.2
10	1.3		5.0	3.6			1.1		0.3	0.4
11i	0.8	0.4	1.0	1.6	0.6	0.4	1.1	0.4		0.4
11	1.1	1.2	4.7	2.8	2.4	1.6	1.0		0.8	1.2
12	0.8		2.6	0.8	1.3				1.1	1.6
13	2.3	2.0	4.9	4.4	2.4	2.4	1.9	4.0	41.9	43.5
15'	42.4	*54.0*	19.6	22.6	10.7	16.9	12.8	*33.9*	2.9	8.9
15''	*44.3*	32.2	23.5	18.5	*21.7*	16.5	*32.7*	19.3	10.8	5.6
15h	1.3	0.8	1.3	0.8	2.3	1.2	4.4	2.4	*32.2*	26.6
X			0.2		0.6				0.2	0.4
O	*0.2*		*3.5*	3.2	11.2	*12.9*	*15.4*	14.5	*0.5*	0.4
X^2	14.700		8.129		14.635		63.132		22.091	
n	5		5		6		5		5	
Critical Value:	11.070		11.070		12.592		11.070		11.070	
Association:	Significant		Not Significant		Significant		Significant		Significant	

The most common plantar main line formula:

Jewish: 15'' (15') . 9.15'' . 15'' . 13(15h)—

Non-Jewish: 15' . 9 . 7(15') . 15' . 13—

PALMAR FORMULAE

Palmar configurations are formulated according to standard methods (Cummins and Midlo, 1943) and the frequencies of similar configurations are calculated for various areas. Right and left palms are combined. The results are presented in tables 2 to 4.

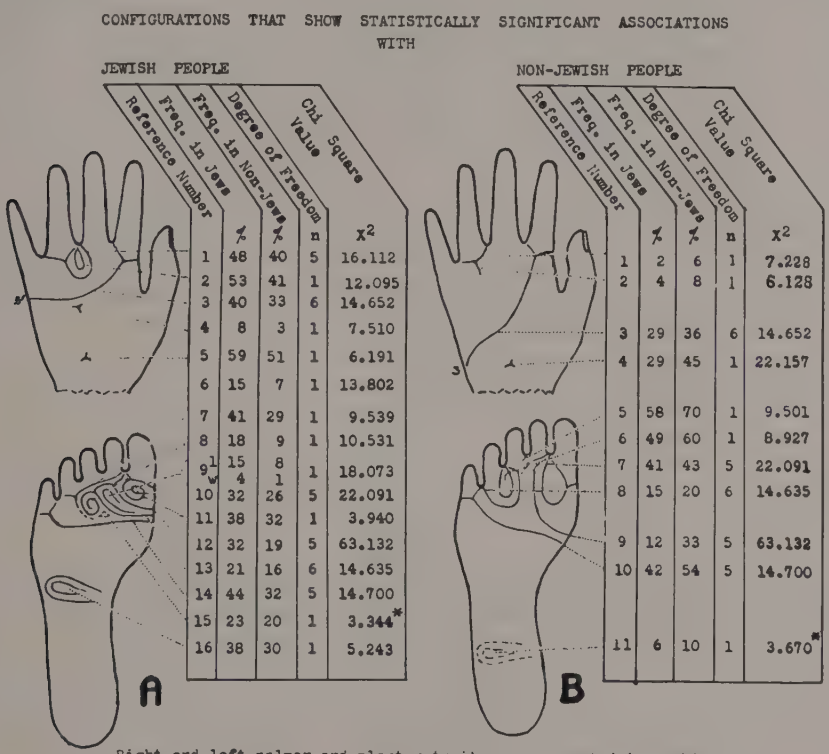
CONFIGURATIONS THAT SHOW STATISTICALLY SIGNIFICANT ASSOCIATIONS WITH
JEWISH PEOPLE
NON-JEWISH PEOPLE
Reference Number
Freq. in Jews
Freq. in Non-Jews
Degree of Freedom
Chi Square Value
%
%
n
X^2
1 48 40 5 16.112
2 53 41 1 12.095
3 40 33 6 14.652
4 8 3 1 7.510
5 59 51 1 6.191
6 15 7 1 13.802
7 41 29 1 9.539
8 18 9 1 10.531
9 15 4 8 1 1 18.073
10 32 26 5 22.091
11 38 32 1 3.940
12 32 19 5 63.132
13 21 16 6 14.635
14 44 32 5 14.700
15 23 20 1 3.344*
16 38 30 1 5.243
1 2 6 1 7.228
2 4 8 1 6.128
3 29 36 6 14.652
4 29 45 1 22.157
5 58 70 1 9.501
6 49 60 1 8.927
7 41 43 5 22.091
8 15 20 6 14.635
9 12 33 5 63.132
10 42 54 5 14.700
11 6 10 1 3.670*
A
B
Right and left palmar and plantar traits are presented in combination on left hand and foot outlines.
* Chi Square Values which approach but do not quite attain statistically significant associations for probability 0.05, the critical value for n 1 being 3.841 .
G.J.S.

FIGURE 3. Configurations showing statistically significant associations with Jewish and Non-Jewish people.

The terminations of each of the four palmar main lines show a marked highest frequency at definite loci among the Jewish people. In general the main lines in Jewish people tend to be crowded into the distal region of the palm with a transverse confluence of the ridges. Among non-Jewish people dermal ridges have a greater tendency to run longitudinally so that line A terminates more frequently at locus 3. The third palmar main line, i.e., line C, is absent in 6 percent of the non-Jews printed, in 2.4 percent of Jewish people. The most frequent main line formula among the Jewish people is 11 . 9 . 7 . 5', while among the non-Jewish it is 11 . 9 . 7 . 3 or 9 . 7 . 5" .5' (table 2).

Palmar axial triradii of Jewish people display two high frequencies; namely, a highest frequency in position t between 10 and 15 percent of the palmar length (from the bracelet crease to the carpophalangeal crease of the third digit) and

TABLE 6

Comparison of frequencies of configurations in the hypothenar, calcar, and thenar areas in Jews and Non-Jews. (Based on 618 Jewish and 248 Non-Jewish soles.)

PATTERN	HYPOTHENAR AREA				CALCAR AREA				THENAR AREA			
	Distal		Proximal		Fibular		Tibial		Proximal		Subdistal	
	Jews	Non-J	Jews	Non-J	Jews	Non-J	Jews	Non-J	Jews	Non-J	Jews	Non-J
O	29.6	33.5	62.9	71.8	99.0	98.4	63.1	71.0	78.0	77.0	96.8	96.4
v	0.8	0.4	5.5	0.4	0.2	0.0	8.9	2.0	9.2	2.8	1.0	0.4
V	20.9	23.4	25.1	17.3	0.2	1.2	28.0	26.6	12.6	19.8	2.3	2.8
Lt	38.2	30.2	6.3	10.8	0.6				0.2			
Lf	0.3											
Ap	10.2	11.7	0.2									

Chi-square for loops and Non-loops:

X^2	5.243	3.670
n	1	1
Association:	Significant	Not Significant

In the calcar and thenar areas nearly all of the configurations tend to be open fields or vestiges.

Symbols: O, open fields; V, vestiges; Lt, loops tibial; Lf, loop fibular; Ap, arch proximal.

TABLE 7

Comparison of configurational frequencies in the plantar hallucal area of Jews and Non-Jews. (Percentages based on 618 Jewish and 248 Non-Jewish sole prints.)

PATTERN TYPES	THENAR DISTAL AREA		FIRST INTERDIGITAL AREA	
	Jews	Non-Jews	Jews	Non-Jews
O	46.1	51.2	51.9	49.2
V	1.1	1.3		1.2
Lt	9.6	10.5		
Lf	1.0	0.8		13.3
Ld	0.3		44.5	35.5
Ap	2.7	2.8	0.2	
At	0.5		0.3	
Af	0.5	0.8	2.4	0.4
W	*38.0*	*32.2*	0.6	

Chi-square test for association of patterns (Loops and Whorls) and patternless (Open fields, Vestiges and Arches).

X^2	2.135	0.945
n	1	1
Critical Value	3.841	3.841
Association:	Not significant	Not significant

Chi-square test for association of Whorls and No Whorls in Thenar and First Interdigital areas combined.

X^2	*3.640*
n	1
Critical Value	3.841
	Association significant

another high frequency in position t', between 30 and 35 percent of palmar length. Two or more triradii per palm are found in 15.7 percent of Jewish palms. Non-Jewish palms show fewer double triradii, and fewer triradii in position t' and t", but 1.5 times as many triradii in the low position of t (tables 3 and figure 1).

In the palmar hypothenar area of Jewish people ulnar and radial loops and also whorls show a higher percentage than in non-Jews. In the thenar and first interdigital areas loops and whorls occur in a few Jewish palms as also in non-Jewish. Second and third interdigital areas show a higher percentage of whorls,

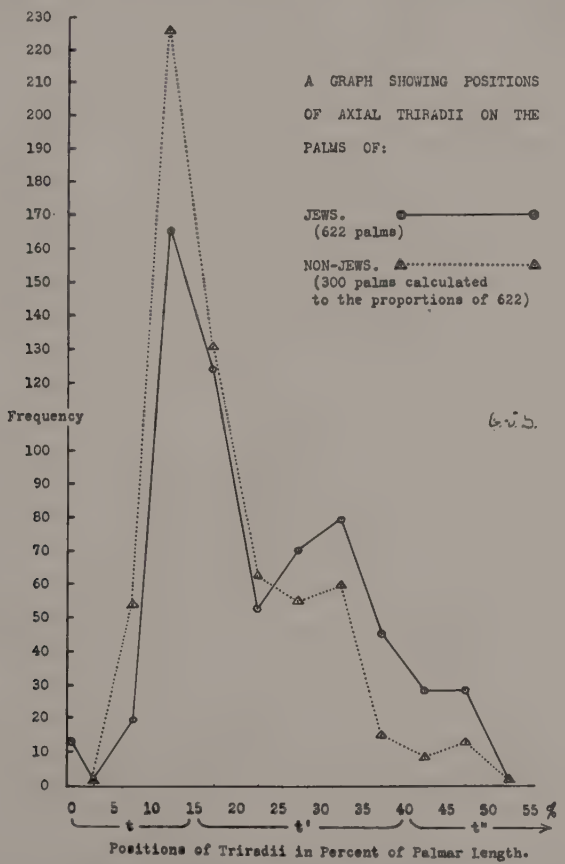

FIGURE 4. Frequency of axial triradii in various positions on the palms of Jews and Non-Jews.

loops, and loops with accessory triradii in Jewish palms. Patterns in the third interdigitial area are significantly associated with Jewish palms. But in the fourth interdigital area the non-Jews have a higher frequency of loops. In all areas of the palm, patterns such as whorls and loops, are more frequent in Jewish palms than in non-Jewish with the exception of loops in the fourth interdigital area.

PLANTAR CONFIGURATIONS

Ridge confluencies distal to digital triradii on the soles of Jewish people show a significantly greater frequency than in non-Jewish (table 9). This means that cutaneous syndactyly is commoner, including fusions of two, three or four toes.

TABLE 8

Comparison of frequencies of plantar configuration in the second, third, and fourth interdigital areas of Jews and Non-Jews. (Percentages based on 618 Jewish and 248 Non-Jewish soles.)

PATTERNS	PLANTAR INTERDIGITAL CONFIGURATIONS					
	Second		Third		Fourth Area	
	Jews	Non-Jews	Jews	Non-Jews	Jews	Non-Jews
O	51.9	68.1	16.5	13.7	66.5	61.7
V	4.4	4.8	3.1	7.7	3.1	13.1
M	2.9	1.2	8.1	3.6	14.2	8.9
A	0.2				0.5	
Lpt	*15.8*	8.9	4.4	4.4	2.9	2.0
Lpf	14.9	11.3	0.2			
Ld	5.5	4.0	49.7	*60.9*	12.1	14.1
W	*4.5*	1.2	*18.1*	9.3	0.5	

Chi-square Test for Association of Patterns (loops and whorls) and Patternless (all other configurations and open fields).

X^2	*13.073*	0.440	0.047
Critical Significance Value		3.841, n = 1	and p = 0.05
	Significant	Not Significant	Not Significant

Chi-square Test for Association of Distal Loops and No Loops in the third interdigital area. n = 1.

X^2	*8.927*
Association:	Significant

Chi-square Test for Association of Whorls and No Whorls in the third interdigital area, n = 1. Critical Value 3.841

X^2	*10.531*
Association:	Significant

TABLE 9

Comparison of ridge confluencies above digital triradii on the soles of Jews and Non-Jews. (Expressed in percentages based on 618 soles of Jews and 248 soles of Non-Jews.)

	Jews		Non-Jews	
	Left	Right	Left	Right
Across Four Digits D, C, B, A	2.3	3.2	0.0	0.0
Across Three Digits C, B, A	11.3	8.7	6.4	7.3
Across Two Digits C, B or B, A	28.2	28.5	24.2	21.8
Total	41.8%	40.4%	30.6%	29.1%
No. of Confluences L & R divided by total No of soles	41.4 ± 2.0%		29.8 ± 1.6%	

Chi-square Test for Association of presence and absence of any Confluences: n 1.

X^2	*9.539*

p 0.05, Critical Value 3.841. Association Significant.

TABLE 10

Comparison of frequencies and of positions of proximal plantar triradii in Jews and Non-Jews. (Expressed in percentages based on 618 Jewish and 248 Non-Jewish prints.)

	INTERDIGITAL AREAS							
	I_1		I_2		I_3		I_4	
	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.	Jews	Non-J.
Left	2.6	2.4	21.7	18.9	12.0	12.9	4.4	5.2
Right	3.4	8.1	25.9	21.8	12.6	9.3	4.4	6.9
Added	6.0	10.5	47.6	40.7	24.6	22.2	8.8	12.1
Average	3.0	5.2	23.8	20.3	12.3	11.1	4.4	6.0

Chi-square test applied for association of Triradii and Absence of Triradii.

n = 1, X^2 =	2.28	3.344	0.56	1.94

For p = 0.05 Critical Value is 3.841. Therefore no associations are statistically significant.

Proximal plantar triradii show a greater frequency (though not significant) in the second and third interdigital areas of Jewish soles compared to non-Jewish. However, in the first and fourth interdigital areas the reverse is the case and non-Jews show a greater frequency (table 10).

In the hypothenar distal area Jewish soles have about eight percent greater frequency of tibial loops than non-Jewish, which association is significant (table 6). More than ninety-nine percent of calcar and thenar (proximal and subdistal) areas are characterized by open fields and a few vestiges. A few rare loops appear on the heels of the Jewish people (table 6). Whorls are found in the hallucal thenar area of 38 percent of Jewish people and only 32 percent of non-Jewish: a significant association (table 7). In Jewish plantar second interdigital areas loops and whorls are greater in number. In the third interdigital area whorls are twice as frequent as in non-Jews. The latter show a high frequency of distal loops in this area. All these associations are significant (table 8). The fourth interdigital area shows no difference of significance.

A significant association of a configuration in favor of one people or another is not always easily discernible. A pattern occurring in a high percentage of both Jews and non-Jews and showing only a small difference between the two may be statistically significantly associated in favor of one, whereas a pattern occurring in a low percentage of cases in both people must show a much greater difference in frequency before it is said to be significantly associated with one or the other people.

Figure 3 illustrates most of the salient Jewish and non-Jewish traits which these tests have revealed to be significantly associated with one or the other of the two Caucasian sub-groups. Figure 3 A shows sixteen configurations statistically significantly associated in favor of Jewish people. The higher percentage frequencies are evident for every configuration in the second column. The third column shows the lower frequencies in the non-Jews. Figure 3 B shows eleven specific configurations significantly associated with non-Jews. Their higher percentage frequencies are given in the third column. In both figures the fifth column shows that all chi-square values (except the one marked with an asterisk) exceed the critical significance value for probability 0.05. Where n is 1, the critical value is 3.841; where n is 5, it is 11.070; where n is 6, it is 12.592. The two configurations marked with an asterisk approach but do not quite attain statistically significant association for probability 0.05.

SUMMARY

Formulation of plantar dermatoglyphics is extended to cover the entire ridge skin areas and as a result new areas of discrete dermal configurations are discovered in the hypothenar distal and proximal regions of the sole.

The dermatoglyphics of 309 Jewish people are compared with 124 non-Jewish Whites. Chi-square tests reveal that the configurations showing a statistically significant association in favor of the Jews are as follows: (See figure 3 A.)

1. Terminations of palmar line C at 9.
2. Distal loops in palmar third interdigital area.
3. Termination of palmar line A at 5′.
4. Axial triradius on the palm at position t″.
5. Axial triradius on the palm at position t′.
6. Double axial triradii on the palm.
7. Ridge confluence across two, three, or four plantar digits.
8. Whorls in the third interdigital area of the sole.
9. Loops and whorls in the second interdigital area of the sole.
10. Terminations of plantar line E at 13 or at 15h.
11. Whorls in the thenar distal area of hallucal patterns.
12. Termination of plantar line A at 15″.

13. Termination of plantar line B at 15".
14. Termination of plantar line D at 15".
15. Proximal plantar triradii in the second interdigital area approach significance.
16. Tibial loops in the hypothenar distal area.

Configurations showing a statistically significant association in favor of non-Jews, are: (See figure 3 B.)

1. Absence of palmar line C.
2. Short termination of line C.
3. Termination of palmar line A at 3.
4. A single palmar axial triradius at position t.
5. Absence of ridge confluence across plantar digits.
6. Loops in the plantar third interdigital area.
7. Termination of plantar line E at 13.
8. Termination of plantar line A at 15'.
9. Termination of plantar line B at 7.
10. Termination of plantar line D at 15'.
11. Tibial loops in the hypothenar proximal area approach significance.

It is therefore shown that palmar and plantar ridge confluence in the Jewish people here studied tends to be more transverse to the long axis of the palm and sole than in the non-Jewish people, that Jewish people have a greater pattern intensity in almost all ridge skin areas than non-Jewish people, and that these differences are statistically significant. This supports the finding of Cummins and Midlo (1943) and Rife (1948).

The extent of the intra-racial variations, as well as the inter-racial, within and between the Jewish and the non-Jewish Whites, is revealed by the percentage frequencies of the configurations which occur in the two groups studied.

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FIVE NEW NORTH AMERICAN SPECIES OF BUPRESTIDAE (COLEOPTERA)

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In recent buprestid studies the following new species were discovered. All type material in collection of author unless stated otherwise.

Acmaeodera robigo n. sp.

♂.—Rather robust; head, pronotum, base of elytra, converging stripe along suture and ventral surface black, elytra reddish brown.

Head convex; surface with median carina on vertex, densely, coarsely punctate, antennae serrate from fifth segment, pubescence moderate.

Pronotum wider than long, slightly wider than base of elytra, widest back of middle, wider at base than at apex, sides rounded, margins not visible from above; disk convex with median basal depression and basal depression each side near lateral margin; surface densely, coarsely punctate, densely pubescent.

Elytra with sides somewhat constricted back of base, then subparallel to back of middle, broadly rounded to apices, margins serrate from middle; disk convex, umbone prominent, large scutellar depression, base transversely corrugated; surface with strial punctures separated by less than half of their diameters, interspaces with fine punctures, each bearing a short hair.

Prosternum truncate, margin not reaching lateral prolonged front angles. Abdomen beneath coarsely, densely punctate, pubescence short; last ventral unmodified.

Length 5.6 mm; width 2 mm.

Holotype and paratypes collected at Lake Corpus Christi, Texas, March 25, 1953 by D. J. and J. N. Knull.

This species is closest to *A. discalis* Caz. (1940). It is shorter, more robust and color of elytra is reddish brown. It lacks lateral black markings of *discalis*.

Chrysobothris beameri n. sp.

Figures 6, 9, 10, 11, 12

♂.—Rather robust, strongly shining cupreous on head and dorsal surface; clypeus margined with metallic green; beneath more brilliant cupreous than above. Pubescence of dorsal surface not evident,

Head convex, a smooth longitudinal carina on occiput; surface finely densely punctate on front, punctures larger on occiput, densely pubescent; antennae extending to about middle of pronotum when laid along side, third segment longest, segments decreasing in length after third.

Pronotum nearly twice as wide as long, wider at base than apex; sides rounded in front, subparallel in middle then rounded at base; apical margin slightly sinuate; basal margin strongly sinuate, median lobe rather narrow, truncate in front of scutellum; disk convex slight median depression in front; surface containing irregular smooth chitinized areas, with rather large, irregular punctures in between areas, more densely punctured laterally. Scutellum small, triangular.

Elytra much wider than base of pronotum; sides rounded in front, then subparallel to back of middle, oblique to rounded apices, serrulate from back of humeral angle; disk convex with two basal depressions on each elytron; surface of each elytron irregular, with four irregular costae somewhat interrupted by irregular densely punctured areas.

Abdomen beneath densely irregularly punctured, punctures smaller and more numerous at sides, sides of each segment with a smooth raised area; last visible sternite serrate on margin, with submarginal ridge, apex broadly deeply emarginate. Prosternum densely irregularly, coarsely punctured, densely pubescent; process considerably expanded back of coxae; with well

developed lobe. Anterior femur with stout tooth serrulate on outside. Anterior tibia arcuate, with broad dilation at apex; middle tibia arcuate; posterior tibia straight.

Length 12.5 mm; width 5.3 mm.

Holotype ♂ labeled Big Bend, Texas, June 24, 1947, R. H. Beamer collector. Deposited in University of Kansas Collection.

This species runs to *C. caurina* Horn in Fisher's key (1942). It can be separated from any of our North American species by shape of ♂ genitalia.

Agrilus parabductus n. sp.

Figures 4, 5

♂.—Form moderately elongate; feebly shining; head and dorsal surface dark bronze, legs and ventral surface lighter bronze, marked with white recumbent scales as follows: in lateral depressions of pronotum, basal depressions of elytra, a band on each elytron in front of middle turned toward lateral margin in middle, two spots on apical fourth, one long suture and one along outer margin, on exposed dorsal segments of abdomen and on sides of last three abdominal segments.

Head convex, slight median depression surface finely rugose, rugae becoming longitudinal on occiput; densely pubescent; antennae short, extending to middle of pronotum when laid along side, serrate from the fifth segment.

Pronotum wider than long, wider in front than at base; sides subparallel in front, strongly constricted back of middle; when viewed from side, marginal and submarginal carinae united back of middle; anterior margin strongly sinuate, median lobe prominent; basal margin transversely sinuate, median lobe truncate; disk convex, with median depression, a strong lateral depression each side, prehumeral carinae prominent; surface finely transversely rugose, finely punctate between rugae. Scutellum transversely carinate.

Elytra wider than base of pronotum; sides subparallel near base, constricted at middle, expanded back of middle, then broadly rounded to obliquely rounded serrulate apices; disk slightly concave along sutural margins, basal depressions prominent; surface finely imbricate.

Abdomen beneath finely punctate, first two segments depressed along median line. Prosternum densely pubescent, pubescent line extending to third segment, process expanded back of coxae, prosternal lobe broadly rounded in front. Tarsal claws similar on all feet, cleft near middle, inner tooth broader and shorter than outer one and not turned inward.

Length 3.7 mm; width 1.1 mm.

♀.—First two ventrals not modified, tergite with a narrow emargination at apex.

Holotype ♂, allotype and paratypes collected at Lake Corpus Christi, Texas, March 25, 1953. Other paratypes same locality March 28, 1952, Frio Co., Texas May 20, 1948 and Val Verde Co., Texas May 24, 1948. All material collected by D. J. and J. N. Knull.

This species runs to *A. abductus* Horn in Fisher's key (1928). It is smaller in size and the genitalia will separate the males. The emarginate tergite will separate the females.

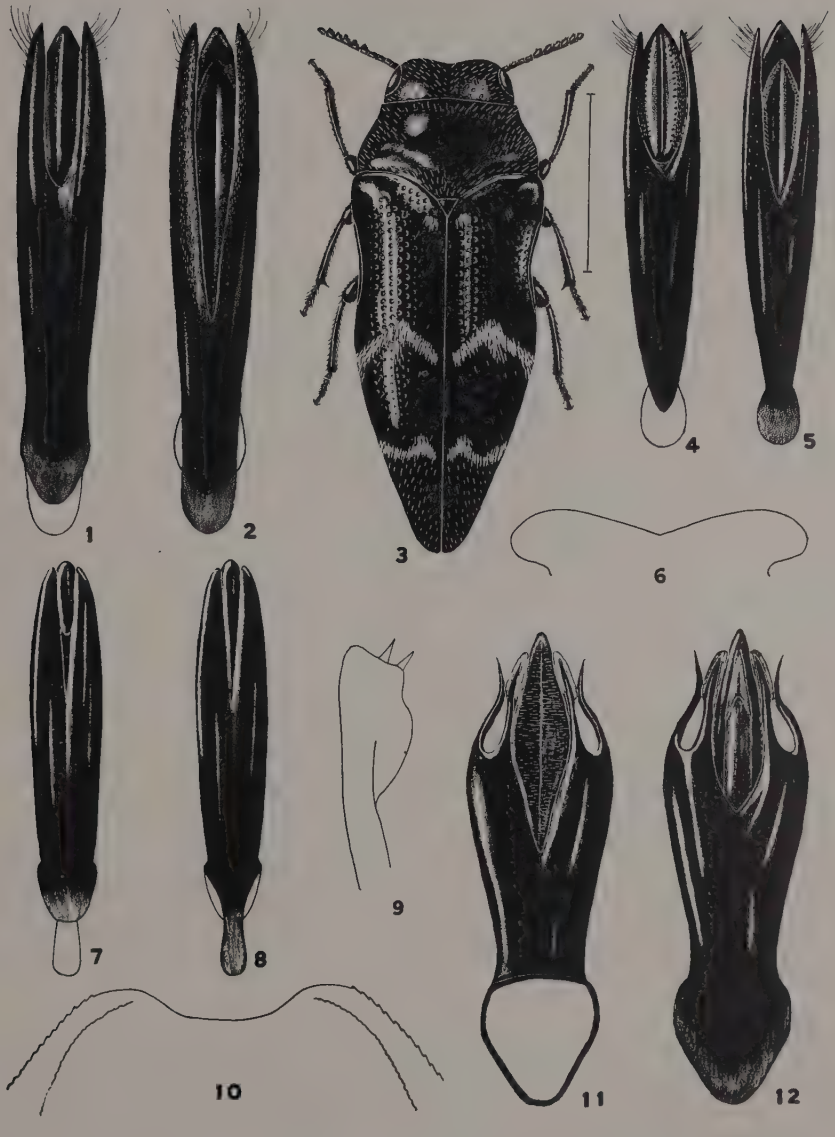
Agrilus bentseni n. sp.

♀.—Form small, rather robust; shining dark bronze throughout; a patch of white pubescence in lateral depression of pronotum, one in basal depression of elytron, an elongate patch at middle and a like patch on apical third of each elytron, rest of dorsal surface with fine pubescence.

Head convex, with well defined median depression; surface finely punctate, slightly rugose on occiput; antennae short, reaching to anterior fourth of pronotum when along side, serrate from fifth segment.

Pronotum convex, wider than long, widest in middle, wider at base than at apex; sides broadly rounded in front, constricted near base, when viewed from side marginal and submarginal carinae joined near base; anterior margin sinuate, median lobe prominent; base strongly sinuate, median lobe truncate; prehumeral carinae lacking, lateral depression each side; surface transversely rugose, minutely punctate between rugae. Scutellum transversely carinate.

Elytra wider than pronotum at base; sides subparallel near base, constricted at middle, expanded back of middle then broadly rounded to rounded serrate apices; disk of each elytron with strong basal depression; surface finely inbricate.



Agrilus pubescens Fisher. 1. Dorsal view of ♂ genitalia. 2. Ventral view of ♂ genitalia.
Taphrocerus albodistinctus n. sp. 3. Dorsal view. Line equals 1 mm. 7. Dorsal view of ♂ genitalia. 8. Ventral view of ♂ genitalia.
Chrysobothris beameri n. sp. 6. Clypeus. 9. Apical portion of ♂ tibia. 10. Last visible sternite. 11. Dorsal view of ♂ genitalia. 12. Ventral view of ♂ genitalia.
Agrilus parabductus n. sp. 4. Dorsal view of ♂ genitalia. 5. Ventral view of ♂ genitalia.

Abdomen beneath finely, sparsely punctate, pubescence short, a small patch of longer pubescence on sides of last three visible abdominal segments. Prosternal lobe subtruncate, with slight emargination, process parallel to behind anterior coxae, then converging to apex. Tarsal claws similar on all feet, cleft near base forming a stout basal tooth, outer claw much longer.

Length 3.7 mm; width 1.1 mm.

Holotype ♀ and paratype of same sex collected in Bentsen Rio Grande State Park, Hidalgo Co., Texas, March 26, 1953 by D. J. and J. N. Knull.

This species runs to *A. blandus* Horn in Fisher's key (1928). It is closest to *A. cercidii* Knull (1937), from which it differs by larger size, median depression of head, carinate scutellum and more bronzy luster.

Taphrocerus albodistinctus n. sp.

Figures 3, 7, 8

♂.—Narrow, elongate, cuneate posteriorly; black, shining; a patch of white recumbent pubescence on each elytron near suture back of scutellum a transverse sinuate band at middle and another like band on apical fourth; other parts of dorsal surface with scattered white hairs.

Head broadly depressed on upper part of front, deeply channeled toward epistoma, clypeus deeply, broadly emarginate; surface minutely punctured, epistoma granulate, a transverse line of dense white pubescence above epistoma, rest of surface with scattered white hairs.

Pronotum much wider than long, widest near base, constricted at apex; anterior margin broadly rounded; basal margin strongly sinuate, median lobe emarginate in front of scutellum; sides converging in front, subparallel at base; disk convex, a transverse depression back of apex, another broader transverse depression at base, a strong lateral depression each side; surface with transverse row of large umbilicate punctures in anterior depression and in lateral depressions, scattered white pubescence more dense in depressions. Scutellum wider than long, triangular, surface granulose.

Elytra back of base wider than base of pronotum; sides constricted back of base, expanded at middle, then strongly converging to separately rounded serrulate apices; disk strongly convex with deep basal depressions on each elytron at middle; surface deeply, coarsely punctate in front of middle white transverse band, punctures finer on posterior half.

Length 2.8 mm; width 1.1 mm.

♀.—Resembles ♂ in size, form and markings and lacks the transverse band of dense pubescence above epistoma.

Holotype ♂ collected at Lake City, Fla., May 18, 1939 by D. J. and J. N. Knull. Allotype labeled Edgewater, Fla., April 8, 1938, F. M. and D. M. DeLong. Paratypes same locality as type, also Brownsville, Texas, March 20, J. S. Caldwell; Hidalgo Co., Texas, April 9, 1950, D. J. and J. N. Knull; Suwannee Springs, Fla., July 3–7, 1948, L. D. Beamer and Royal Palm Park, Fla., July 22, 1948, R. H. Beamer. Paratypes in The University of Kansas Collection.

This species can be separated from our other forms by its cuneate shape, dense white bands of pubescence on elytra and shape of ♂ genitalia.

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THE AGE OF THE ORDOVICIAN KIRKFIELD FORMATION IN ONTARIO

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Limestones of Middle Ordovician Trenton age occur in Ontario in two separate areas of outcrop, one a band running roughly southeast from Georgian Bay to Lake Ontario, the other a series of more or less disconnected exposures in faulted blocks in the Ottawa Valley and St. Lawrence lowland. Between these two areas lies the pre-Cambrian Frontenac axis. Although considerable distances are involved (Hull is 170 miles from Kirkfield), correlation of beds across the axis have been made with assurance, and formational names defined in one area have been applied to beds in the other. Thus the name Hull has been used for beds in each area.

Study of the faunas involved made me suspect that this correlation was incorrect and in 1942 I prepared a paper for the Ottawa meeting of the Geological Society of America, setting forth my views, and suggesting that the local name Kirkfield be revived for the Central Ontario beds, since it implied no correlation. The Ottawa meeting was cancelled, but the abstract of my paper was published. At that time I was dissuaded from publication of my notes by the argument that further detailed field-work was needed for final solution of the problem, and that controversy should be avoided until this could be done. This, I think, was sound advice. Two considerations bring me to presentation of my data now. The detailed mapping which was needed is now being done, but my abstract, with its threat of publication, hangs over the heads of the men doing it. I think it well to drop the other boot, present my opinions, and let other workers get on with the task of proving them right or wrong. Then, too, in the past decade the term Kirkfield has gained some acceptance, but as a unit succeeding the Rockland (see *e.g.*, Kay 1948, p. 1402), a usage which I deplore.

This ten-year delay is not regretted. In 1942 my conclusions had to rest largely on my own collecting experience, with the inevitable suspicion of unconscious bias involved in such data. Now, however, we have a detailed study of the Black River (Young, 1943) and a series of faunal studies of the Ottawa Valley beds (Wilson, 1946–1951) which can be used in evidence.

I suggest that the Kirkfield formation (the beds previously called Hull in Central Ontario) are not of Hull age, but rather are contemporary with the Rockland beds of the Ottawa Valley, a conclusion which I think follows from a study of the nature of these three units.

THE NATURE OF THE HULL FORMATION

In his first division of the limestones of Trenton age in the Ottawa Valley Raymond did not name his members, but numbered them from 1 to 6 (1912, p. 354). His numbers 2 and 3 are described:

"(2) Thick and thin-bedded blue limestone with a large amount of chert, developed as flat plates parallel to the bedding. These beds are particularly well shown in Hull, and furnish a large part of the building stone and crushed stone used in Ottawa. Just at the top of these beds are the layers from which a large part of the crinoid found in Hull have been obtained. Strata of the same age as these beds occur in central Ontario at Fenelon Falls and the Kirkfield lift-lock, where they occupy the same stratigraphic position as at Ottawa. The thickness of these beds is about 65 feet.

"(3) Massive, coarse-grained, blue-grey limestone with few fossils. This is the horizon in which are located the large quarries on Montreal road, three miles east of Ottawa. The

same beds are exposed in Hull, but are not quarried at the present time. They seem to be absent from the section in Simcoe district, central Ontario. The most common fossil is a species of *Tetradium*, very like *T. cellulosum*. The thickness is about 35 feet."

The next year (Raymond, 1913, p. 143) these descriptions were repeated with the members named, as the Crinoid beds and the Tetradium beds. Further brief notes, including a few fossils, are given in the same guidebook, pp. 151, 156.

FAUNAL ZONE	JOHNSTON 1911, 1912	RAYMOND 1914	KAY 1937	OKULITCH 1939	KAY 1942	SINCLAIR 1952
CRINOID	KIRKFIELD	HULL	HULL		HULL	KIRKFIELD
DALMANELLA		ROCKLAND				
GONIOCERAS	COBOCONK	LERAY	ROCKLAND (NAPANEE)	COBOCONK	NAPANEE	COBOCONK
TETRADIUM CELLULOSUM	LOWVILLE	LOWVILLE		MOORE HILL	CHAUMONT	MOORE HILL
BEATRICEA	LOWER LOWVILLE	PAMELIA		GULL RIVER		GULL RIVER

FIGURE 1. Summary of the nomenclatural history of Lower Mohawkian beds in Central Ontario. The double line is drawn between the Trenton and the Black River groups. Johnston considered his Kirkfield group to be pre-Trenton in 1911, and in 1912 extended it higher, to include beds not shown in this table.

ZONES	RAYMOND 1916	KAY 1937	KAY 1942	WILSON 1946	SINCLAIR 1952
TETRADIUM	HULL	HULL	HULL	OTTAWA FORMATION: HULL	HULL
CRINOID					
DALMANELLA	ROCKLAND	ROCKLAND: NAPANEE	ROCKLAND: NAPANEE	ROCKLAND	ROCKLAND
PAQUETTE RAPID	BLACK RIVER		SELBY	LERAY	CHAUMONT
"LERAY"		SELBY	CHAUMONT		
TETRADIUM CELLULOSUM	LOWVILLE			LOWVILLE	LOWVILLE
	PAMELIA			PAMELIA	PAMELIA

FIGURE 2. Summary of the nomenclatural history of Lower Mohawkian beds in the Ottawa Valley. The double line is drawn between the Trenton and Black River groups.

The name Hull was first used in 1914 (Raymond, 1914, p. 348) in a table in which it was used for the Crinoid beds, with the note:

"The name Hull is proposed for the strata which at Ottawa, Belleville, and in central Ontario, carry the well-known crinoid fauna. The name is for the city of Hull across the Ottawa river from Ottawa."

In this paper the Tetradium beds were omitted from the table.

Later (Raymond, 1916, p. 255) the Hull formation was defined, in the Ottawa valley section, as:

"Coarse-grained light gray thick-bedded limestone, thirty-three feet in thickness, resting upon sixty-six feet of blue to gray fine-to-coarse grained limestone containing great quantities of black chert in layers and flattened cakes. The upper beds contain an abundance of *Stromatocerium* and *Solenopora* and in a nearby locality *Tetradium racemosum*. The lower beds have shaly partings in which great numbers of fine echinoderms have been found, particularly crinoids. Among the characteristic fossils are *Edrioaster bigsbi* and *Cleiocrinus regius*. Hull formation. 100 feet."

Since 1916 this interpretation of the formation has been accepted. In present usage of the Canadian Survey the Hull is considered a faunal association within the inclusive Ottawa limestone. I do not consider this interpretation helpful, but the disagreement is one of terminology only. The same beds are meant whether they be called a formation or a series of beds containing a given fauna.

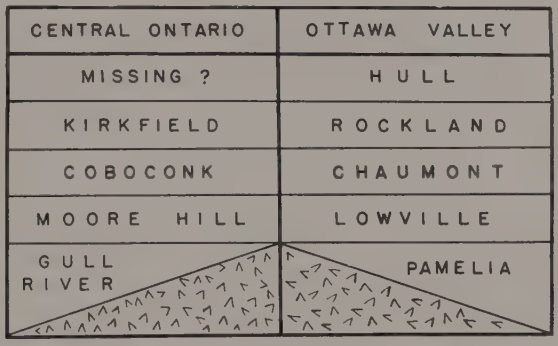

FIGURE 3. Suggested correlation between Central Ontario and the Ottawa Valley. The Gull River and Pamelia may be equivalent, but I do not consider this to be demonstrated and there are important faunal differences.

The Hull echinoderms

Wilson lists the following species from the Hull in the Ottawa district (Wilson, 1946):

Ateleocystites huxleyi Billings
Comarocystites punctatus Billings
Lichenocrinus ottawaensis Wilson
Cyclocystoides halli Billings
Archaeocrinus microbasilis (Billings)
Glyptocrinus ottawaensis Wilson
G. ramulosus Billings
Periglyptocrinus billingsi Wachsmuth and Springer
Ectenocrinus canadensis (Billings)
Carbocrinus radiatus Billings.

I think the first reaction of readers will be surprised at the brevity of the list. But after years of collecting in the Hull, I can testify that it does represent the Hull fauna. At one time, when the Hull quarries were working and there was an ardent group of local collectors (James Stewart, Walter R. Billings, Sir James Grant, J. E. Narraway, T. W. E. Sowter, and others) a fair number of specimens were collected, apparently all from a thin zone. But specimens are now very rare, and the variety is, and seems always to have been small.

Much confusion has been caused among those not personally familiar with the locality by the fact that the best exposures of the higher "Cystid" beds, in which crinoids are common, are in the city of Hull. If one sees an old collection of crinoids labelled "Trenton limestone, Hull," one naturally assumes that they are from the Hull "Crinoid" beds. Thus Foerste, Bather and Bassler were misled, and the literature is very confused.

This confusion is in part unnecessary, since Billings was usually careful to indicate the horizon of his specimens, but his notes have been generally overlooked.

Billings recognized two series of beds at Ottawa yielding echinoderms, the lower cherty beds (Hull), and the higher thin-bedded limestones (Cystid beds) (Billings, in Logan, 1863, p. 166). He lists the species which he obtained from the latter, viz.:

Amygdalocystites radiatus
Comarocystites punctatus
Glyptocystites multiporus
Pleurocystites elegans
P. filitextus
P. robustus
P. squamosus
Palasterina stellata
Petraster rigida
Stenaster pulchella
Edrioaster bigsbyi
Lebetodiscus dicksoni
Carabocrinus radiatus
Cleiocrinus regius
Dendrocrinus gregarius
D. rusticus
Glyptocrinus lacunosus
G. marginatus
G. ornatus
Hybocrinus conicus
H. tumidus
Lecanocrinus elegans
Palaeocrinus angulatus
Porocrinus conicus
Reteocrinus stellaris
Rhodocrinus pyriformis

In other words, of the 44 echinoderm species which he described from the Ottawa district, Billings definitely stated that 27 came from the higher of the two horizons. The other 17 species were not located stratigraphically, with the exception of *Ateleocystites huxleyi*, which was said to occur in the lower beds.

The non-crinoid fauna of the Hull

The Hull beds in their typical expression are so unfossiliferous that it is difficult to get more than a partial picture of the fauna from ordinary collecting. We are fortunate in having Wilson's studies, based on the accumulated collections of almost 100 years by officers of the Canadian Survey, and by Walter R. Billings and other local amateur collectors. For convenience the following list of species which are found in the Hull in the Ottawa district has been compiled from Wilson's papers (Wilson, 1946a, 1947, 1948, 1951):

Brachiopods:
Lingula curta Conrad
L. elongata Hall
L. hullensis Wilson
L. philomela Billings
L. rectilateralis major Ruedemann
Trematis ottawaensis Billings
Schizocrania filosa Hall
Pholidops trentonensis Hall
Platystrophia amoena McEwan
P. a. longicardinalis McEwan
Dalmanella rogata (Sardeson)
Dinorthis iphigenia (Billings)
D. pectinella cf. *sweeneyi* (Winchell)
D. regularis Wilson
D. subquadrata (Hall)
D. s. alternata Wilson
Sowerbyella sericea (Sowerby)
Rafinesquina alternata (Conrad)
R. a. intermedia Wilson
R. a. plana Wilson
R. a. transversa Wilson
R. semicircularis Wilson
Camerella hemiplicata (Hall)
Rhynchotrema increbescens (Hall)
Zygospira recurvirostris (Hall)
Trilobites:
Bathyurus ingalli Raymond
B. spiniger (Hall)
Isotelus gigas DeKay
I. latus Raymond
I. maximus Locke
Bumastus billingsi Raymond and Narraway
Thaleops ovata Conrad
Acrolichas cucullus ottawaensis Foerste
A. narrawayi Foerste
Flexicalymene senaria (Conrad)
Ceraurus dentatus Raymond and Barton
C. pleurexanthemus Green
Calliops alatus (?) Okulitch
C. callicephalus (Hall)
Calyptaulax ottawanus (?) Okulitch
Achatella achates (Billings)
Corals:
Streptalasma corniculum Hall
Lichenaria typa Winchell and Schuchert
Tetradium cellulosum (Hall)
Sponges, etc.
Solenopora compacta (Billings)
Hindia parva Ulrich
Brachiospongia hullensis Wilson
Receptaculites occidentalis Salter
Gastropods and conularids:
Sinuites bilobatus corrugatus (Hall)
Lophospira serrulata (Salter)
L. ventricosa (Hall)
Hormotoma bellicincta (Hall)
H. gracilis (Hall)
H. trentonensis crassa Wilson
Liospira vitruvia (Billings)
Cyclonema cushingi Ruedemann
C. hallianum Salter
C. montrealense Billings
Conularia trentonensis Hall

To this list we may add *Cladophragmus bifurcatus* (Raymond, 1931, p. 182). Concerning the groups which have not yet been published by Wilson I can add little. In some of the more sugary layers of the "Tetradium beds" large cyrtodontid pelecypods are common, but they have not been studied. However, it may be said with confidence that they form a faunule quite unlike anything in the Rockland or the Sherman Fall, although one which maintains its character in beds of Hull age as far east as Pont Rouge, Quebec. The ostracods are quite unknown, although small smooth forms are common locally. The bryozoans are being studied by Dr. M. A. Fritz, but her descriptions are not yet published (see Fritz, 1947).

THE NATURE OF THE ROCKLAND FORMATION

Like the Hull, the Rockland was first described by Raymond in faunal terms, as in 1913 (p. 142):

"Dalmanella Beds.—Thinbedded, pure, blue-black limestone, characterized by *Orthis tricenaria*, etc. These beds are very poorly exposed at Ottawa, and have an estimated thickness of about 40 feet (12.2 m.). They are well shown above the Black River in the Stewart quarry at Rockland, and were also seen on top of the Black River at Fenelon Falls and Kirkfield lift-lock in central Ontario."

The name Rockland was introduced (1914, p. 348) with the notes:

"The name Rockland is proposed for the lowest Trenton beds in the Ottawa valley and in central Ontario, and the name is from the town of Rockland on the Ottawa River, about 30 miles east of Ottawa."

These beds as typically exposed in the Stewart quarry were fully described by Wilson (1921, p. 19 seq.), and for convenience the fauna may be extracted from her lists:

Sponge:
- *Receptaculites occidentalis* Salter

Corals:
- *Streptelasma corniculum* Hall
- *S. profundum* (Conrad)
- *Tetradium fibratum* Safford

Bryozoa:
- *Dianulites rocklandense* Wilson
- *Hemiphragma tenuimurale* Ulrich
- *Nicholsonella ottawaensis* Wilson
- *Pachydictya acuta* (Hall)
- *Prasopora grandis* Ulrich
- *P.* cf. *insularis* Ulrich
- *P. simulatrix orientalis* Ulrich

Brachiopods:
- *Camerella panderi* Billings
- *Cyclospira bisulcata* (Emmons)
- *Dalmanella rogata* (Sardeson)
- *Orthis disparilis* Conrad (Billings in error)
- *O. tricenaria* Conrad
- *Parastrophia hemiplicata* (Hall)
- *Petrocrania ulrichi* (Hall and Clarke)
- *Plectambonites sericeus* (Sowerby)
- *Plectorthis plicatella* Hall (*pectinella* in error)
- *Rafinesquina alternata* (Emmons)
- *R. rugosa* Wilson
- *Rhynchotrema increbescens* (Hall)
- *Strophomena filitexta* Hall
- *Triplecia cuspidata* (Hall)
- *T. extans* (Emmons)
- *Zygospira recurvirostris* (Hall)

Pelecypods:
- *Cyrtodonta* cf. *billingsi* Ulrich
- *C. huronensis* Billings

Gastropods:
- *Bucania punctifrons* Emmons
- *Hormotoma bellicincta* (Hall)
- *H. trentonensis* Ulrich and Scofield
- *Liospira americana* (Billings)
- *Lophospira bicincta* (Hall)
- cf. *Maclurina cuneata* Whitfield
- *Maclurites logani* Salter
- *Metoptoma estella* Billings
- *Phragmolithes compressus* Conrad
- *Sinuites cancellatus* (Hall)
- *Subulites elongatus* Conrad
- *Trochonema umbilicatum* (Hall)

Trilobites:
- *Bumastus indeterminatus* (Walcott)
- *B. trentonensis* Emmons
- *Calymene senaria* Conrad
- *Ceraurus* cf. *dentatus* Raymond and Barton
- *C. pleurexanthemus* Green
- *Encrinurus cybeleformis* Raymond
- *E.* cf. *trentonensis* Wolcott
- *Isotelus gigas* DeKay

THE NATURE OF THE KIRKFIELD FORMATION

The Kirkfield limestone group was proposed by Johnston (1911, p. 189) to include (a) Dalmanella sancti-pauli beds, (b) crinoid beds (c) Trenton beds, the first two members being thought of as pre-Trenton. It is evident that this classification reflected the advice of Ulrich, who was not familiar with the Ottawa valley sequence.

The following year, with Raymond doing his paleontology, Johnston (1912, p. 257) divided his Kirkfield limestone group into (1) Dalmanella beds, (2) crinoid beds, (3) Prasopora beds, and (4) an "Upper member (unknown)." With the introduction of Ottawa valley formational names by Raymond in 1914 the name Kirkfield passed from use until 1942.

In his study of the Trenton Kay recognized that the "Hull" and the "Rockland" of Central Ontario in the sense of Raymond, i.e. the crinoid beds and the Dalmanella beds of Johnston, formed a single indivisible unit, to which he applied the name Hull (Kay, 1937, p. 261). I did not agree with this correlation, and suggested that the name Kirkfield be revived, in a restricted sense, since it implied no correlations with the Ottawa Valley (Sinclair, 1942, p. 1833). This suggestion was adopted by Kay (1943, p. 599), but his continued use of Rockland as a subjacent time unit has largely nullified the unambiguous usage for which I had hoped.

At any rate, we are agreed that the term Kirkfield applies to the combined Dalmanella beds and crinoid beds as described by Johnston and Raymond in Central Ontario.

The Kirkfield echinoderm fauna

This is the only part of the Kirkfield fauna which has been studied in any detail, and Springer's paper on the crinoids is well-known (Springer, 1911). The following species have been reported from these beds in the Kirkfield area:

Amecystis laevis (Raymond)
c *Amygdalocystites florealis* Billings
hc *A. f. laevis* W. R. Billings
c *A. radiatus* Billings
c *Archaeocrinus lacunosus* (Billings)
hc *A. microbasilis* (Billings)
c *A. pyriformis* (Billings)
c *Astrocystites ottawaensis* (Whiteaves)
Astroporites ottawaensis Lambe
hc *Carabocrinus radiatus* Billings
C. vancortlandi Billings
c *Cheirocrinus logani* (Billings)
hc *Cleiocrinus regius* Billings
c *Cremacrinus articulosus* (Billings)
c *C. inaequalis* (Billings)
C. rugosus (W. R. Billings)
c *Cupulocrinus conjugans* (Billings)
C. cylindricus (Billings)
c *C. humilis* (Billings)
C. jewetti (Billings)
C. latibrachiatus (Billings)
hc *Cyclocystoides halli* Billings
Daedalocrinus bellevillensis (W. R. Billings)
D. kirki Ulrich
c *Dendrocrinus proboscidiatus* Billings
Edrioaster bigsbyi (Billings) see note
Eustenocrinus milleri (Wetherby)
E. springeri Ulrich
Foerstediscus parvus Bassler
Glaucocrinus falconeri Parks and Alcock
Glyptocrinus circumcarinatus Parks
hc *G. ramulosus* Billings
Glyptocystites multiporus Billings (see note)
Hemicystites multibrachiatus (Raymond)
c *Heterocrinus tenuis* Billings
Hybocystites eldonensis Parks
H. problematicus Wetherby
c *Isorophusella incondius* (Raymond)
Isotomocrinus typus Ulrich
Lebetodiscus dicksoni (Billings) (see note)
Lichenocrinus ornatus Fenton
Ontariocrinus devratus Jaekel
Ottawacrinus billingsi Springer
O. typus W. R. Willings (see note)
c *Palaeocrinus angulatus* (Billings)
h *Periglyptocrinus billingsi* Wachsmuth and Springer
P. priscus (Billings)
Pleurocystites mercerensis Miller and Gurley
c *P. squamosus* Billings
c *P. s. robustus* Billings
c *Porocrinus conicus* Billings
c *Protaxocrinus laevis* (Billings)
hc *Pycnocrinus ornatus* (Billings)
Reteocrinus alveolatus Miller and Gurley
c *Stenaster salteri* Billings
Protaster whiteavesianus Parks

The list has been taken from Bassler and Moody (1943, pp. 29–30) and from Springer. In this list I have marked with a "c" the 25 species which occur in the cystid beds at Ottawa, with an "h" the eight species which occur in the Hull. From this list one must delete *Ottawacrinus typus* (see Bather, 1913, p. 13), *Edrioaster bigsbyi* (see Bather, 1914, p. 171: the Kirkfield species is *E. laevis*), *Glyptocystites multiporus*, which is *G. grandis* (see Sinclair, 1948, p. 311) and *Lebetodiscus dicksoni* (see Raymond, 1921, p. 6).

I have not included *Astroporites ottawaensis* nor *Daedalocrinus bellevillensis* in the comparison, since I do not know at what horizon they occur at Ottawa, and Wilson does not give them.

Non-crinoid fauna of the Kirkfield

Kay (1934) has described prolific ostracod faunas from Kirkfield beds in central Ontario, and it is regrettable that similar faunules are not known from the Ottawa valley, as their evidence in correlation would carry much weight. Specimens of bryozoans are abundant in the Kirkfield, but they are unstudied. The macroscopic fauna which I have personally collected from the Kirkfield quarry is listed below. Although I consider, with Kay, that the Dalmanella beds and the crinoid beds are a unit, it has been thought better to restrict the list to those forms collected from one outcrop of the crinoid-bearing part of the sequence. This eliminates a number of species which were found on weathered dumps, but their loss does not seem to be significant.

"Sponge":
Receptaculites occidentalis Salter

Coral:
Streptelasma corniculum Hall

Brachiopods:
Resserella "rogata" (Sardeson)
Dinorthis pectinella (Emmons)
Hesperothis tricenaria (Conrad)
Platystrophia amoena McEwan
P. canadensis
P. trentonensis McEwan
Plectorthis trentonensis Winchell and Schuchert
Rafinesquina alternata (Emmons)
Rhynchotrema increbescens (Hall)
Sowerbyella curdsvillensis (Foerste)
Strophomena filitexta (Hall)

Gastropods:
Holopea rotunda Ulrich and Scofield
Hormotoma bellicincta (Hall)
H. gracilis (Hall)
Liospira americana (Billings)
Phragmolithes compressus Conrad

Trilobites:
Bumastus bellevillensis Raymond and Narraway
Ceraurus dentatus Raymond and Barton
Encrinurus cybeleformis Raymond
Hemiarges paulianus (Clarke)
Isotelus gigas DeKay
Raymondites ingalli (Raymond)

Most of these species are those of any Trenton faunule, and are not significant, but some are of interest when their distribution in the Ottawa valley is noted. The Rockland contains a *Bumastus* of *bellevillensis* type, which is replaced in the Hull by the very different *B. billingsi*, as *Sowerbyella "sericea"* replaces *S. curdsvillensis*.

I think the relationships of the Kirkfield fauna can best be seen by examining in detail Kay's faunal description of the central Ontario "Hull" (1937, p. 262):

> "Among the distinctive and persistent forms are the trilobites *Encrinurus cybeleformis* Raymond, *Hemiarges paulianus* (Clarke) and *Bathyurus ingalli* Raymond; none of these is known from the horizons not in the Hull. In northwestern New York and southern Ontario, the basal Hull is the lowest member in which *Parastrophina hemiplicata* (Hall) is abundant; it is found also in younger formations. *Strophomena filitexta* is common, and, in contrast to the Rockland, specimens of *Rafinesquina* are few. *Hesperorthis tricenaria* (Conrad) and *Receptaculites occidentalis* Salter are not found above the Hull and the genus *Platystrophia* is first represented by uncommon species in the formation. . . . "

Taking these statements seriatim: *Encrinurus cybeleformis* was listed from the Rockland by Wilson (1921, p. 44) and in her later paper (1947, p. 44) she notes it as occuring from the Leray to the Cobourg. *Hemiarges paulianus* is found in the Leray, Sherman Fall and Cobourg, but not in the Hull (ibid., p. 43). *Bathyurus ingalli* has been decribed from the Paquette Rapid beds (Sinclair, 1944). Wilson has listed *Parastrophina hemiplicata* as common in the Rockland (1921, p. 32) but it does not become abundant at Ottawa until the Sherman Fall. No *Strophomena* (nor any of its homeomorphs) has been found in the Hull, where species of *Rafinesquina* are abundant, and in many beds the only fossils. *Hesperorthis* is abundant in the Rockland, but does not occur in the Hull, although it appears again high in the Cobourg as a rare species. Although Wilson (1948, p. 29) has two records of *Receptaculites occidentalis* in the Hull, it is very rare there, in contrast to its abundance in lower beds. At least two species of *Platystrophia* occur at Paquette Rapid, and Wilson has noted species of the genus from a number of pre-Hull beds (Sinclair, 1946; Wilson, 1946, p. 31–33).

I think if the faunas which I have listed are carefully studied, the conclusion will be inescapable, that the Kirkfield beds have nothing important in common with the Hull, but on the contrary are strikingly similar to the Rockland. On the basis of our present knowledge, I would consider the Rockland and Kirkfield contemporary, although not necessarily with identical limits.

BEDS OF PRE-ROCKLAND AGE

Were this discussion only concerned with the correlation of isolated formations in Ontario, there would be little excuse for presenting it as fully as I have done. But the problems is much larger in scope. If the Kirkfield be Hull, then it may be argued plausibly that the beds beneath the Kirkfield may be Rockland, and the beds below them Black River. This was essentially Kay's position in 1937, and on that basis he found that the typical Rockland formation rested on beds of Rockland age (Kay, 1937, p. 251), a dilemma which he resolved by redefining the Rockland. Let us try to state the relevant facts.

Three faunas may be distinguished in the Ottawa valley between the Lowville and the Hull. The lowest is that seen in beds along the Petite Chaudière rapids on the Ottawa river, just above the cites of Ottawa and Hull, at Mechanicsville and Tétreauville (or Val Tétreau) on either side of the river. This is the fauna which has been called "Black River," or "Leray" (see Raymond, 1913, p. 141). From these beds a number of trilobites were described by Raymond and Narraway (1908, 1910, etc.), cephalopods by Foerste (1932–33 and other papers), brachiopods by Wilson (1932), and their fauna is being redescribed in detail in Wilson's Ottawa formation papers. There is no need to go into details of that fauna.

Above beds containing this fauna are others (very poorly seen at Ottawa) which at Rockland, on the Bonnechère, and at Paquette Rapid on the Upper Ottawa river carry an abundant fauna which has been well described (see Kay, 1942, p. 598, for a partial list of species). In general the Canadian reports have tended to call this fauna "Leray," or to speak of it, and the beds containing it, as transitional between the Black River and the Trenton. The fauna will be called "Paquette Rapid," when reference is necessary.

Then appears the typical Rockland, with its own fauna, which has been discussed in detail above.

Kay's statement that the "Black River" beds of the Ottawa Valley were really Trenton, and indeed upper Rockland (Kay, 1937, p. 252) was disturbing. Still the Canadian assignment of these beds to the Black River had been largely a positional interpretation, since the fauna of the typical Leray was so poorly known, and the traditional correlation seemed to require re-examination. Since Kay gave no fauna for the Black River itself, there was little basis for judgement. In order to obtain data for the solution of the problem, I spent two weeks at Watertown in 1938, collecting in the typical Leray. A small fauna was collected, and later listed (Sinclair, 1945, p. 74). Since it has considerable importance, the list may be repeated here.

I found the Leray to be very sparsely fossiliferous, and the few fossils it contained very difficult to collect and prepare. However, I did obtain from beds of cherty limestone, above the Lowville and below the Watertown, the following identifiable species:

Columnaria halli Nicholson
Lambeophyllum apertum (Billings)
L. profundum (Conrad)
Camerella cf. panderi Billings
Rafinesquina alternata (Emmons)
Rhynchotrema increbescens (Hall)
Cyrtodonta canadensis Billings
Vanuxemia inconstans Billings
Helicotoma cf. *H. larvata* Salter
Liospira vitruvia (Billings)
Maclurites logani Salter
Illaenus cf. *I. latiaxiatus* Raymond and Narraway
Isotelus gigas DeKay

Although this fauna was so small, it could be placed in terms of the Ottawa Valley sequence, and it correlated not with the Ottawa "Leray," but with the overlying Paquette Rapid beds. In other words, on the basis of this fauna the Ottawa "Leray" was not younger, but older than the typical Leray. Since the fauna was so meagre, it was not felt wise to publish conclusions based on it.

Later one of Kay's students studied the Black River formations and faunas in detail, and his results (Young, 1943, p. 233 seq.) were anxiously studied to see what information his more intensive work would yield. Young's results were found to accord with my own conclusions. After deleting forms from the Ottawa Valley, central Ontario and Montreal, the fauna Young listed for the Chaumont in its typical expression, i.e., in northwestern New York, was:

Stromatoporoid:
Stromatocerium rugosum Hall
Corals:
Columnaria halli Nicholson
Lambeophyllum profundum (Conrad)
Lichneria minor Winchell and Schuchert
Tetradium cellulosum (Hall)
T. fibratum Safford
Bryozoan:
Rhinidictya mutabilis (Ulrich)
Brachiopods:
Hesperorthis tricenaria (Conrad)
Leptaena radialis Okulitch
Rafinesquina clara Okulitch
R. minnesotensis (Winchell)
Rhynchotrema cf. *minnesotensis* Sardeson
R. cf. *increbescens* (Hall)
Hormotoma gracilis (Hall)
Gastropods:
Lophospira perangulata (Hall)
Trochonema umbilicatum (Hall)
Cephalopods:
Actinoceras ruedemanni Foerste and Teichert
A. tenuifilum (Hall)
Cycloceras decrescens (Billings)
C. romingeri Foerste
Endoceras subcentrale Hall
Goniocerus anceps Hall
Orthoceras multicameratum Hall
Plectoceras undatum (Conrad)
Trilobite:
Ceraurinus scofieldi (Clarke)
Ostracod:
Leperditia fabulites Conrad

Again this fauna, insofar as it permitted comparison, pointed to the Ottawa Valley Paquette Rapid beds: the *Hesperorthis*, *Gonioceras* and *Lichenaria* being particulary indicative. Certainly there is nothing here to justify an assignment of the Ottawa Valley "Leray" beds, or the succeeding Paquette Rapid beds, to the Trenton rather than to the Black River.

The pre-Kirkfield beds in Central Ontario have been adequately discussed by Okulitch (1939), and need not be discussed here in detail. I agree with Okulitch that the Coboconk is to be correlated with the Chaumont.

GENERAL CONCLUSIONS

The Kirkfield formation of central Ontario is considered to be the same age as the Rockland of the Ottawa Valley. No beds of Hull age have been recognized in central Ontario. The pre-Rockland beds, both in the Ottawa Valley and central Ontario, are considered to be of Chaumont age. The history of the problem, and my views, are summarized in the correlation tables.

APPENDIX

Age of Rocks at the Chaudière Falls, Ottawa

In compiling the list of Hull species from Wilson's monograph of the Ottawa echinoderms, I omitted those from her locality 37, "Table rock, Chaudière Falls." This omission must now be justified. In my opinion these beds are in the cystid beds of the Middle Trenton, and not in the Hull. This opinion is based on my experience that (a) these beds can be walked and seem to be continuous with those on Philemon Island, which are indubitably Cystid beds. (Walking here is an energetic matter, calling for much clambering under bridges, but it can be done and I have done it—some years ago), and (b) at low water it is possible to get down into wide joints and see, below the beds containing the echinoderms, the shalier beds of the typical "Sherman Fall" as it is identified at Ottawa.

However, these are evidences which may be convincing only to me, and I offer these considerations in addition. Although Wilson lists many forms from this locality, all but one of them is also found in the "Cobourg," and frequently locality 37 is the only "Hull" record for the species. (2) *Pleurocystites* is very common at Table rock, but Raymond says (1916, p. 260), "The Hull . . .contains many many echinoderms but very few *Pleurocystites*, these fossils being abundant in a zone seventy-five feet higher in the section. It was from these higher beds that *Pleurocystites squamosus* and the other species described by Billings were obtained . . . the cystids are associated with species of the *Clitambonites* fauna." (3) *Clitambonites* (recte *Vellamo*) is common at Table Rock. (4) *Lebetodiscus dicksoni* was described from Table rock, but Raymond (1921, p. 6) says, "All the individuals of this species whose exact locality is known have been found in the Cystid beds of the Prasopora zone. . ."

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Mathematical Engineering Analysis. *Rufus Oldenburger.* The Macmillan Company, New York. 1950. xiv+426 pp. $6.00.

Recently there has been an increased emphasis on what has been termed "making engineers scientists." This book is an attempt in this direction. The author is a mathematician who has given serious attention to the applied mathematics required in setting up industrial engineering problems. His central aim is to develop a feeling for the mathematical representation of physical situations. Thus the text is concerned with setting up problems mathematically rather than with the mechanics of their solution.

One very important feature is the attempt to build up an ability to make suitable simplifying assumptions in the solution of engineering problems. In this phase the author gives many sidelights and suggestions based on his own personal experience in order to show what assumptions can be made *safely*.

The book is kaleidoscopic in its range of topics treated. This wide selection of topics plus the fact that methods of solution are not stressed gives an inherent disorganization to the material. In an effort to give some organization to the subject matter it is arranged according to general fields:

I. Mechanics of Rigid Bodies.
II. Electricity and Magnetism.
III. Heat.
IV. Elasticity.
V. Fluid Mechanics.

In each section the basic laws are set forth and the subject matter developed from these. A set of problems is given at the end of each section. Answers and hints on solution for all problems are found in the Appendix.

I found the presentation interesting and the book certainly has its value. However, the organization and scope of the material covered would not recommend it as a text, but rather as a reference book. It would be valuable in a seminar for senior engineering students in the mathematical formulation of engineering problems.

Occasionally the author succumbed too much to the engineer's statement of laws and was not as rigorous as one would desire. A typical example is in the formulation of Newton's Second Law of Motion. He speaks only of the "force" causing an acceleration and not the "unbalanced force." This is a subtle difference, to be sure, but often a subtle difference is the difference between success and failure.

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Semimicro Qualitative Analysis. *Paul Arthur* and *Otto M. Smith.* McGraw-Hill Book Co., New York. Third edition, 1952. xi+285 pp. $4.00

Organic Chemistry. The Chemistry of the Compounds of Carbon. *Lucius J. Desha.* McGraw-Hill Book Co., New York. Second, revised edition, 1952. xvi+595 pp. $6.50.

Development of the Guided Missle. *Kenneth W. Gatland.* Philosophical Library, Inc., New York. 1952. x+133 pp. $3.75.

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NATURAL PARTURITION OF A PORCUPINE AND FIRST REACTIONS OF THE PORCUPETTE[1]

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Direct observations of natural parturition in a porcupine are so rare that the following notes, taken during the birth of a porcupette (Shadle, 1950a) in the Vivarium at the University of Buffalo, were considered to be sufficiently valuable as to be recorded in detail. All previous porcupine parturitions at the Vivarium have occurred during the night or early morning, and so have escaped observation.

On May 4, 1952, three male porcupines, (*Erethizon d. dorsatum*) and two pregnant females were obtained from Allegany State Park, N. Y., and brought back to the colony at the Vivarium. Four days later, at 4:00 P.M., May 8, cries of an adult porcupine were heard in the porcupine room and one of the recently caught pregnant females was found in labor. The female was promptly placed in a separate cage where she completed the birth process, during which timed notes were made of the parturition and the early reactions of the newborn.

Since all times cited are in the afternoon, the designation P.M. is intentionally omitted, but is to be understood throughout.

At 4:05 the pregnant female was complaining a good deal, she was in advanced labor, and the birth was already under way, for the nose of the young was visible in the vulva. Five minutes later, the struggles of the young tore the extra-embryonic membranes. The head of the porcupette, still covered by the torn membrane, protruded from the mother's vagina, and the young was struggling and crying lustily. The expulsion of the young porcupine was rather rapid.

The male porcupette was born at 4:13, the completely collapsed extra-embryonic membranes were partially discharged, and the young continued to call quite loudly. It lay struggling on the cage floor with the umbilical cord still attached to its belly, and to the placenta, which had not yet been discharged. The porcupette staggered up on all four feet, but when the female moved off to one side, it was immediately drawn over flat upon its left side by the unbroken umbilical cord.

At 4:16, as the porcupette lurched about while still attached by the umbilical cord, the mother happened to step on the umbilical cord with her right hind foot, and as the porcupette staggered away from her right side, a tug by the young broke off its umbilical cord about three-quarters of an inch from the porcupette's belly. The young was now free and able to move about as it chose, so the mother followed the young, keeping quite close to it. The protruding extra-embryonic membranes dragged behind the female as she walked about the cage. Very little blood, probably not more than a half cc, was lost by the breaking of the umbilical cord.

Five minutes after birth, at 4:18, the mother continued to follow the young, and when it stopped she sat on her haunches with the anterior part of her body hunched over above it, in a protective position. Although she assumed a nursing attitude, the porcupette did not attempt to nurse.

Ten minutes after birth, the porcupette uttered a low cry and the mother immediately walked up in front of it and again assumed the nursing position holding

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her fore limbs loosely in front of her and at her sides. She reached down once and touched the young lightly with her right front paw, but did not attempt to take hold of it, nor draw it to her. She followed every move of the young and repeatedly assumed the nursing position, but she made no audible sounds after having been taken away from the other porcupines with which she had been confined.

An elm twig was put into the cage at 4:28 and the mother began to feed on the fresh leaves. The porcupette soon changed its location slightly and the mother immediately left her food and hurried over to the young. Eighteen minutes after the birth (4:31) the extra-embryonic membranes and placenta were discharged. The mother immediately turned around and began to sniff at the placenta, and then nibbled at it momentarily. The placenta with the attached membranes weighed approximately 55 gr and the little male porcupette weighed 400 gr.

Twenty minutes after birth the porcupette showed its first real defensive reaction, viz., the erection of its quills. The eyes of the porcupette were wide open at birth, the four incissors, and four pre-molars were ready to function. At 4:37 he bit the finger of the diener who was carrying him from the scales back to the cage. The porcupette struck feebly with the tail, but when he was picked up by placing one hand directly under his belly, he showed only very slight objection to being handled.

When he was 29 minutes old the mother approached him touching his guard hairs with her nose. To this tactile stimulus he reacted immediately by striking at her with his tail.

While his first reactions seemed almost entirely involved in crying out and struggling to free himself during the process of birth, these reactions were followed by a period involving efforts to right himself to a normal position on all four feet, with active efforts to coordinate its leg movements and maintain the normal standing or walking position. These efforts resulted in an upright position and a fairly stable equilibrium within the first hour. The strength, sureness, and coordination of his muscular activity improved rapidly.

His early respiratory reactions were quite rapid and shallow. When 42 minutes old his respiratory movements occurred at a rate of 75–77 per minute. He soon lay down and rested momentarily while near him, his mother lay stretched out on her belly, on the floor. Two minutes later when his mother walked up to him and assumed the nursing posture, the porcupette struck at her twice with its tail. At five o'clock the mother was sitting hunched over him, and from time to time she lowered her nose and touched the hairs of his back.

The few quills which had been driven into the observer by the strokes of the tail were all approximately one-half inch long, and they were already partly dry and stiff enough to penetrate the skin readily. The scalecovered quills held fast in the human skin and the roots of the quills pulled out of the porcupette readily. Many of these dislodged quills were still in the growing stage, for the quill roots were wide open, like the actively growing base of a pinfeather.

Now for the first time, at 5:05 he "presented his rear end to the enemy" in a protective "avoiding or defense reaction" (Shadle, 1943, 1944). He showed this reaction toward both the observer and also towards his mother whenever he saw either one move. As the mother sat in the nursing position, the porcupette, when one hour old, approached her and pushed his head into the dark shadow area beneath her body. This was his first demonstration of the "head hiding reaction" which is such a typical defensive reaction of all wild porcupines of any age. The mother chattered or clicked her teeth to her offspring. This is a type of communication used by porcupines of all ages, and its vigor, volume, and intensity express various degrees and types of individual reactions, from simple quiet recognition between mother and young, through annoyance, fear, anger and noisy, vicious defiance during fighting (Shadle, 1950b). Even when he was one hour old,

he had not yet made any attempt to nurse. At this point, it was necessary to discontinue the observations.

At 10:45, when approximately six and a half hours old, the porcupette was found nursing actively. He and his mother were in the typical nursing positions, and his mouth and lips were making the characteristic sucking and smacking sounds which often accompany the nursing reaction. During the nursing, the mother sat hunched forward with her fore limbs hanging limply toward her front and sides.

By eleven o'clock the porcupette was mouthing the elm twigs from which its mother had stripped the leaves. He made no definite effort to gnaw the bark, for his reactions seemed more like a baby putting something into its mouth and shutting down on it, rather than a real gnawing action. The porcupette was again picked up and handled quite tenderly but the mother was still somewhat solicitous and remained quite close by, but she made no active defense of the young when it was picked up or handled. When the observer imitated a porcupine call, the mother came towards him as if she thought it was the porcupette, or another porcupine calling. It may have been on her part a mild defense reaction to protect the young, for she repeated several times her response to the frequent imitations of the porcupine call. At no time did she attempt to attack or bite the observer, but evidenced interest in the imitated call.

When seven hours old, the porcupette was breathing much more slowly, (52–55 respirations per minute) almost one-third fewer respirations than had been observed during the first hour. At this time his muscle coordination enabled him to scratch his nose quite deftly with his right front paw.

The following day, May 9, 1952, the porcupette weighed 15 gr less, (385 gr), than his birth weight. He was active, moved around freely and when handled carefully he was much more tractible than the day before, but would still strike lightly with his tail when picked up, or when touched.

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Comparative Embryology of the Vertebrates. *Olin E. Nelsen.* The Blakiston Co., New York. 1953. xxiii+982 pp. $8.00.

A compilation of information and some misinformation in the field of vertebrate morphology, but one without any serious attempt to critically evaluate the views expressed by other workers in science. A great deal of data has been brought together and organized in such a way as to make it more readily available for use or reference by an advanced worker or even by a lecturer. It should serve a greater utility as a reference or source book than as a text-book for any of the standard courses in vertebrate morphology. In general it is well illustrated, but several erroneous concepts have been perpetuated in the illustrations.

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NATURAL ENEMIES AND INSECTICIDES THAT ARE DETRIMENTAL TO BENEFICIAL SYRPHIDAE

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FACTS ABOUT SYRPHIDAE

Flies in the family Syrphidae, called syrphid flies, flower flies, sweat flies, hover flies, or drone flies, belong to the order Diptera, suborder Brachycera, section Cyclorrhapha. They are small, medium, to large flies, smooth or pilose, dull to brightly colored. Many of the most common species are distinguished while in flight by their darting movements and their suspended flight above flowers, whereby they have acquired the name "hover flies."

Almost all types of bees, bumblebees, social wasps and solitary wasps are mimicked by syrphids, and so often does this occur throughout the family that they form one of the most striking examples of what appears to be protective mimicry. The resemblance is complete in some species even to a humming sound while in flight much like that of a bee. The resemblance of *Xylota chalybea* (Wied.) to some of the black hunting wasps is complete, even to a rapid twitching of the wings when resting or moving about on the ground.

Adult syrphid flies may be found almost anywhere, and some are quite common. Most of them visit flowers in sunny spots, but some occur only in woods, in moist places, in fields, or near ants' nests, depending upon their feeding and oviposition habits. Almost any locality, except arid ones, should yield nearly one hundred species over an extended period of persistent collecting, notably during the spring and early summer months. Several state check lists exceed two hundred species.

In economic importance the Syrphidae comprise one of the foremost families of the Diptera. The adult flies of this family are considered by some authorities to be second only to honeybees in importance as pollinators. It is the author's opinion that their importance in this respect varies with the locality, with the plants to be pollinated, and from year to year, bumblebees and other Hymenoptera often being of greater importance in effecting pollination. Adult syrphids frequent flowers and feed upon nectar and pollen. Various species visit many of the same plants frequented by bees, wasps, skippers, and tachinid flies, transporting pollen from flower to flower as they go. It is difficult to measure the great service thus performed. In addition, the larvae of syrphids of several genera are predaceous on aphids and certain other Homoptera. They are generally rated second to the ladybird beetles among the aphidophagous predators. A few species attack Psylliidae (=Chermidae), Cercopidae, and lepidopterous larvae.

Ewing (1914) included syrphids in a list of 14 natural predators on the common red spider, or spider mite, *Tetranychus telarius* L.

The family is a beneficial one, except for a few species wherein the larval stage is injurious to growing bulbs and a few other plants (Wilcox, 1927). Medical annals record several scattered cases of myiasis caused by syrphids larvae, particularly those in the rat-tail maggot group (James, 1947).

Based on his extensive studies in California of Syrphidae and their parasites, Kamal (1926a) stated, "The aphis-feeding syrphids rank as high, and under certain conditions higher, than our common ladybird beetles in their efficiency as plant lice enemies. On account, therefore, of the usefulness of these flies, a study of their natural enemies is of unusual importance from an economic standpoint."

Fluke (1929) ranked Syrphidae first among the natural enemies of the pea aphid, *Macrosiphum pisi* (Kalt.), followed according to their importance in this respect by Coccinellidae, fungus diseases, *Aphidius* (Braconidae), and Chrysopidae.

Metcalf (1916) considered the syrphid, *Pipiza pisticoides* Will., to be the most important enemy of the wooly apple aphid, *Eriosoma lanigera* (Haus.), in Maine.

Fluke (1929) encouraged the use of certain cultural practices to foster beneficial syrphids, such as the planting or retaining of shrubs and trees which annually harbor plant lice, in areas adjacent to crops which are subject to attack by aphids. Wild raspberry, dogwood, goldenrod, roses, and elms are among the best plants for this purpose. These plants will become infested with aphids, generally other than those species which attack cultivated plants, which, in turn, will attract aphidophagous syrphids. Fluke (1929) cited an instance in Wisconsin in which a small field of peas near an open woods was practically free from aphids, and on almost every vine was a syrphid egg or larva. Another field just a quarter of a mile away, but surrounded by cultivated, pastured, or bare fields, was heavily attacked by the pea aphid, *Macrosiphum pisi* (Kalt.). The latter field was later abandoned and plowed under, as hardly a single good pod developed. A large syrphid, *Scaeva pyrastri* (L.), which is abundant in the far west, consumes many aphids in its development. It is a strong flier and occurs in large numbers. Fluke (1929) suggested its introduction into new localities for the biological control of aphids.

While many syrphids are of little or no economic importance, many species in the following genera are important as predators in the larval stage on aphids: *Allograpta*, *Baccha*, *Mesograpta*, *Melanostoma*, *Paragus*, *Pipiza*, *Scaeva*, *Syrphus*, *Metasyrphus*, and *Sphaerophoria*. Others in the genera *Baccha*, *Pipiza*, *Scaeva*. *Syrphus*, and *Metasyrphus* are predaceous in their larval development on coccids, *Salpingogaster nigra* Sch. is a common enemy of the sugarcane froghopper, *Tomaspis saccharina* Dist., in the British West Indies, and is highly effective in the biological control of this pest. Guppy (1913, 1914) published a fairly good discussion of the propagation and introduction of this syrphid into Trinidad and Tobago for the control of sugarcane froghopper nymphs. The larvae of *Syrphus ropalus* Wlk., being negatively phototropic, retreat to the inner surface of the outer leaves which enclose the heart spike of the cabbage tree of New Zealand (Miller and Watt, 1915), and there they destroy caterpillars of *Venusa verriculata*. *Xanthandrus comptus* Harr. in Europe, in addition to being aphidophagous, has been observed to be a common predator upon larvae of *Pieris brassicae* L., *Cnethocampa pinivora* Tr., and other lepidopterous larvae, according to Smith (1936). *Sphaerophoria sulphuripes* Thomson is recorded by Davidson (1916) as predaceous on the bean thrips, *Heliothrips fasciatus* Perg., in southern California. It is with these beneficial species that this report is concerned.

The larvae of most of these may be found feeding amid colonies of aphids. In some species of the predaceous larvae, the larvae pupate among the aphid hosts upon the foliage, whereas in others they descend to the ground and form their puparia in rubbish. The pronounced tendency toward migration on the part of many mature larvae seems to be induced by a need for fairly moist surroundings for pupation. In fields of aphid-infested crops a scarcity of mature larvae and puparia often is noted. A search usually will reveal that large numbers of larvae have moved to the field margins and have pupated in damp soil along ditch embankments, or in more shaded areas, some penetrating to a depth of 10–15 cm. Often the puparia are massed in great numbers in particularly favorable spots.

Publications dealing with or referring to the Syrphidae are quite extensive, hundreds of papers having been published specifically on Syrphidae. The preponderance of these, however, are of a taxonomic nature or deal with beneficial activities of aphidophagous Syrphidae. Information concerning enemies of Syrphidae is scattered and incomplete; even less information has been published concerning the effect of insecticides upon syrphids. The greater part of the data published dealing with natural enemies of syrphids are on various parasites, almost all of which belong to the order Hymenoptera.

INSECTICIDES

The information on the effects of various insecticides upon Syrphidae is extremely limited. Reasons for this probably are several: failure to recognize the important role which Syrphidae play in the control of aphids and other pests of ornamentals and agricultural plants, with a corresponding lack of available funds for research on this question, usual inability to avoid harming the beneficial insects when immediate control of a pest by insecticides is needed, and the unwillingness on the part of companies manufacturing insecticides to conduct experiments on the harmful effects of their products on beneficial Syrphidae when it can be anticipated that the results will not enhance the sale of their products.

Research is needed to determine which of two or more insecticides is least harmful to Syrphidae and other beneficial predators and parasites where there is little or no difference, otherwise, in the effectiveness of the several insecticides. From one such series of tests, Morrill (1921) reported that the larvae and adults of the ladybird beetle, *Hippodamia convergens* Guer., were unaffected by the application of nicotine dust upon melon vines infested with aphids. Likewise, the larvae of Syrphidae were not affected visibly, and even the adults of *Aphidius*, a small hymenopterous parasite, largely survived.

Metcalf (1916) investigated the effect of contact insecticides, such as are used for plant lice, on syrphid larvae, in the hope that an effective spray for the aphids could be found which would not destroy the syrphid larvae. In this way the latter might be left on the plants to seek out and destroy any aphids which escaped the spray, and thus tend to make the control measures perfect—a compatibility of insecticide and natural control. From his investigations Dr. Metcalf found that in laboratory tests a solution of Black Leaf 40, 1 to 1000 of water with soap added, killed every aphid and only a small percentage of the syrphid larvae.

In Germany, Grosswald (1934) came to the conclusion that pyrethrum is much less destructive to tachinid and ichneumonid parasites of the nun moth than are arsenical compounds, and that the parasitization in dusted areas is even higher than in those receiving no treatment. This observation is of value when related to internal parasites, but has little significance for external predators, such as the Syrphidae. The important factors here are the degree of kill upon application of the insecticide and the degree of residual action.

In general, insecticides which rapidly lose their effectiveness, such as rotenone, nicotine, pyrethrum, hydrocyanic acid gas, etc., are not so detrimental to the beneficial forms. They may kill the larval or adult predators and adult parasites which are present upon the foliage during the period immediately following the application, but those parasites emerging thereafter, and those predators which soon invade the controlled area, are not affected. As a result often there is a marked increase of parasites and predators in relation to that of the host. A nonvolatile material may bring about almost complete mortality of beneficial insects, and consequently no assistance in control is afforded by the beneficial forms. For example, Jancke (1935) has shown that the winter application of tar distillates to woolly apple aphid infestations kills the parasite *Aphelinus* so completely that recolonization is necessary the following spring. Similar difficulties have been encountered in the use of DDT, so that its use has had to be abandoned.

New organic insecticides present a serious problem, since many are much more deadly to beneficial parasites and predators than the older insecticides long in use. Also, no chance to build up a tolerance for these new insecticides has been afforded the beneficial insects in so short time.

NATURAL ENEMIES OF SYRPHIDAE

Parasites

By far the most serious enemies of syrphids, at least of the aphidophagous species, are the parasitic Hymenoptera, primarily of the superfamily Ichneumo-

noidea. Hymenopterous parasites of Syrphidae are found among the following familes: Braconidae, Ichneumonidae, Encyrtidae, Eupelmidae, Pteromalidae, Chalcididae, Figitidae, Ceraphronidae and Diapriidae. Many of the species which are parasitic on or in Syrphidae are specific to one or a few closely related host species. The ichneumon *Diplazon laetatorius* (Fab.) is a notable exception to this rule, having a wide variety of dipterous hosts; it also attacks some Coleoptera and Lepidoptera. This parasite is by far the most common and most detrimental in Ohio. Its distribution is almost universal, and in some years it has been credited with parasitizing upwards of 75 percent of several species of *Syrphus* and *Metasyrphus*. Kamal (1939) reported that during some summers in California, parasitism by *D. laetatorius* amounted to almost 40 percent.

Curran (1920) stated: "It has been found that syrphid larvae of all species are more or less heavily parasitized some years much more severely than others. During 1919, parasites were over twice as numerous as during 1915."

The literature on parasites of Syrphidae is widely scattered, most often consisting of a brief statement of parasites reared from some syrphid. Several papers, however, are worthy of special mention: three papers by Kamal (1926a, 1926b, 1939), a paper by Spencer (1926) which deals with the biology of parasites and hyperparasites of aphids, including a review of the literature, and bulletins by Metcalf (1913, 1916), Fluke (1925, 1929), and Heiss (1938).

The important parasites of syrphids occur in four hymenopterous families: Ichenumonidae, Figitidae, Encyrtidae, and Pteromalidae. Of the ichneumons, the common, previously mentioned *Diplazon laetatorius* is probably the most important. As a parasite, it lays its eggs in the larva of the host or in the egg on a leaf. The adult female destroys many other eggs of syrphids by feeding on them. Kamal (1926a) described observing a female *D. laetatorius* drilling a hole in an egg with her ovipositor and then sucking the contents dry. This predaceous habit has been observed also by Heiss (1938) amd Metcalf (1913). When the egg of the parasite is laid in the egg of the host, the larva does not hatch until after the host larva has hatched. In either case the adult emerges from the host puparium through a ragged hole bitten from the anterior end. One parasite only emerges from each host. The species of *Syrphoctonus*, according to Kamal, oviposit in the larva only.

The encyrtids are multiple parasites, and from five to 30 individuals emerge from one host through a small round emergence hole, usually at the side and ventrad. The species of the genus *Bothriothorax* emerge from both host larvae and host puparia, in which they cause a characteristic, lumpy, cobblestone-like deformation of the body surface. The numerous oval swellings of the surface are indications of internal cavities occupied by the developing parasites. According to Kamal (1926a), *Pachyneuron allograptae* Ashm. (a synonym of *Pachyneuron syrphi* (Ashm.)) and the species of *Conostigmus* are pupal parasites, laying their eggs on the surface of freshly formed puparia.

The figitids (formerly within the family Cynipidae) emerge from the puparia of the hosts, one from a host. Which stage of the host is actually attacked has not been ascertained. All Figitidae in the subfamily Aspiceratinae are parasites in syrphid puparia.

A parasitized puparium can be detected within a few hours after its formation; the integument becomes unusually dark with a brassy or slightly greasy sheen. The puparium often fails to round up properly and is notably more slender than a normal one. If the investigator is still in doubt, it is only necessary to await the normal emergence of the syrphid, which takes an average of seven days in the summer. If the fly does not emerge on schedule it is usually parasitized, for the parasites always take longer for their development than the syrphid. The ichneumons emerge in from ten days to two weeks, the encyrtids in about the same length of time, and the figitids take from 24 to 39 days for their emergence after the pupation of the host.

In the summer, *Diplazon laetatorius* and the encyrtid parasites rank first in importance. During the spring and fall, Ichneumonidae of the genus *Syrphoctonus* are most devastating. Work on the biology of hymenopterous parasites of aphidophagous syrphids is being carried on in the Laboratories for the Study of Beneficial Insects, at the Citrus Experiment Station, Riverside, California. Other investigations of hymenopterous parasites are being conducted at the Laboratory for the Investigation of Insect Parasites, Belleville, Ontario, Canada.

The following table lists hymenopterous parasites of Syrphidae in North America, the species attacked by each parasite, where specific hosts are known, and the distribution of each parasite, according to Meusebeck *et al.* (1951).

TABLE 1

*Hymenopterous parasites of Syrphidae in North America.**

*For references to publications treating parasites in this list, see *Hymenoptera of North America, Synoptic Catalogue*, by Muesebeck *et al.*, 1951.

Parasite	Host	Distribution
Braconidae		
Alysiinae		
Asobara barthii Brues	*Temnostoma balyras* (Walker)	Wis. (Milwaukee).
Ichneumonidae		
Celinae (=Cryptinae)		
Ethelurgus syrphicola (Ashmead)	*Allograpta obliqua* (Say)	Atlantic west to Ill. in Transit. and U. Austr. Zones.
	Syrphus rectus O. S.	
Rhembobius abdominalis pacificus (Harrington)	*Eumerus strigatus* (Fall.)	Sask., Colo., Wash., Calif.; Hawaii.
	Merodon equestris (Fab.)	
Diplazoninae—Members of this subfamily are parasitic on Syrphidae. They oviposit into the egg or young larva of the host and emerge from the puparium. The species are mostly of northern distribution.		
Diplazon annulatus (Gravenhorst)		Greenland; Europe.
Diplazon laetatorius (Fab.)	*Allograpta exotica* (Wied.)	Transcont. in Canad.
	A. obliqua (Say)	
	Baccha clavata (Fab.)	
	B. lemur O. S.	
	Eupeodes volucris O. S.	
	Mesograpta polita (Say)	
	Metasyrphus perplexus (Osburn)	
	M. vinelandi (Curr.)	
	M. wiedemanni (John.)	
	Paragus bicolor (Fab.)	
	P. tibialis (Fall.)	
	Platycheirus erraticus Curr.	
	Scaeva pyrastri (L.)	
	Sphaerophoria cylindrica (Say)	
	S. robusta Curr.	
	Syrphus rectus O. S.	
	S. ribesii (L.)	
	S. vittafrons Shan.	
	S. torvus O. S.	
Diplazon pectoratorius (Thunberg)		Transcont. and Canad. and Huds. Zones; Eurasia.
D. scutellaris (Cresson)	*Allograpta obliqua* (Say)	Atlantic to 100° W. in Transit., U. Austr., and L. Austr. Zones; Mexico.
	Baccha clavata (Fab.)	
	Metasyrphus vinelandi (Curr.)	
	Sphaerophoria cylindrica (Say)	
D. tetragonus (Thunberg)		Transcont. in Transit. and Canad. Zones; Europe.
D. tibiatorius (Thunberg)	*Eupeodes volucris* O. S.	West of 100° W. from Alaska to Mexico in the Huds., Canad., and Transit. Zones; east of 100° W. in Canad. Zone; Europe.
	Sphaerophoria cylindrica (Say)	
	Syrphus opinator O. S.	

TABLE 1—(Continued)

Parasite	Host	Distribution
Enizemum ornatum (Gravenhorst)		Alaska, Alta., N. Mex., Greenland; Eurasia.
E. petiolatum (Say)	*Metasyrphus wiedemanni* (John.)	Atlantic to Cont. Divide. Transit.and U.Austr.Zones.
Phthorima bidens (Davis)		N.H., N.Y., W.Va., Mich.,
P. extensor Cushman		Mass., N.Y., N.J., Pa., Md., Va.
Promethes cultriformis (Ashmead)		Atlantic to Sask. in Canad. and Transit. Zones.
Promethes elongatus (Provancher)	*Platycheirus erraticus* Curr.	Transcont. in Huds., Canad.
	Sphaerophoria robusta Curr.	and Transit Zones.
P. sulcator (Gravenhorst)	*Sphaerophoria robusta* Curr.	Transcont. in Transit. Zone; Europe.
Syrphoctonus agilis (Cresson)	*Allograpta obliqua* (Say)	Transcont. in U. Austr. to
	Metasyrphus wiedemanni (John.)	Huds. Zones.
	Sphaerophoria cylindrica (Say)	
	S. robusta Curr.	
S. alaskensis (Ashmead)		Alaska (Popof Isl.)
S. albopictus (Davis)		Colo., Alta., Wash., Ore., Calif. Transit. Zone.
S. belangerii (Provancher)		Que. to S. C. and La.
S. compressiventris (Cresson)	*Platycheirus erraticus* Curr.	Transcont. in Transit. Zone.
S. cressonii Davis		Nev.
S. cultriformis (Davis)		Colo.
S. decoratus (Cresson)	*Eupeodes volucris* O. S.	Pacific to Cont. Divide.
	Metasyrphus sp.	Transit Zone.
	Sphaerophoria cylindrica (Say)	
S. elegans var. *nigritarsus* (Gravenhorst)		Greenland; Europe.
Syrphoctonus foutsi Cushman		Maine, Mass., N. Y., Md., D. C., Ohio, Ill.
S. gillettii Davis		Colo.
S. groenlandicus (Holmgren)		Greenland.
S. humeralis (Provancher)	*Allograpta obliqua* (Say)	West of 100° from Alaska to
	Eupeodes volucris O. S.	Mexico; also in the Transit.
	Scaeva pyrastri (L.)	Zone east to the Atlantic.
S. laevis Brues		Atlantic to Cont. Divide. Transit. Zone.
S. maculifrons (Cresson)	*Cheilosia alaskensis* Hunter	Minn., Iowa, S. Dak., and
	C. hoodiana (Bigot)	Rocky Mts. to Pacific. U.
	Eupeodes volucris O. S.	Austr. Zone.
	Metasyrphus sp.	
	Paragus tibialis (Fall.)	
	Scaeva pyrastri (L.)	
	Syrphus sp.	
S. melanogaster (Holmgren)		Greenland.
S. minimus (Cresson)		Atlantic to 100° W., L. Austr., U. Austr., and Transit. Zones.
Syrphoctonus pacificus (Cresson)	*Allograpta obliquea* (Say)	Rocky Mts. to Pacific, and
	Eupeodes volucris O. S.	S. Dak. and Alaska. Tran-
	Metasyrphus sp.	sit. Zone.
	Scaeva pyrastri (L.)	
	Syrphus sp.	
S. pallipennis (Provancher)		Que.
S. pectoralis (Provancher)		Transcont. in Transit., Canad., and Huds. Zones.
S. pleuralis (Cresson)	*Syrphus torvus* O. S.	Transcont. in Transit. Zone.
		Atlantic to Cont. Divide. Transit.and U.Austr.Zones.
S. robustus Davis		Alta., Wash.
S. vertebratus Cushman		N. H. (top of Mt. Washington).

TABLE 1—(Continued)

Parasite	Host	Distribution
Zootrephus bizonarius (Gravenhorst)		Transcont. in Canad. and Transit Zones; Europe.
Z. ichneumonoides (Provancher)		Transcont. in Canad., Transit., and U. Austr. Zones; Alaska.
Z. rufiventris (Gravenhorst)	*Platycheirus erraticus* Curr.	Transcont. in Canad. and Transit. Zones; Europe.
Encyrtidae		
Encyrtinae		
Bothriothorax californicus Howard	*Scaeva pyrastri* (L.)	Calif.
	Metasyrphus nitens (Zett.)	
	S. opinator O. S.	
B. faridi Kamal	*Syrphus opinator* O. S.	Calif.
B. flaviscapus Girault		U. S.
B. nigripes Howard	*Eupeodes volucris* O. S.	N. Mex., Calif.
B. peculiaris Howard	*Metasyrphus wiedemanni* (John.)	N.H., N.J., Va., Ill., Wis.
	Syrphus rectus O. S.	
	S. ribesii (L.)	
Syrphophagus quadrimaculatae (Ashmead)	*Pipiza quadrimaculata* (Panzer)	S. C., Fla., Miss.
S. smithi Kamal	*Syrphus nitens* (Zett.)	Calif.
	S. opinator O. S.	
Eupelmidae		
Arachnophaga aureicorpus (Girault)	? syrphid	S. C., Tex.
Pteromalidae		
Sphegigasterinae		
Pachyneuron siphonophorae (Ashmead)	*Baccha clavata* (Fab.)	N.Y. to N.C., Tenn., and Ill.; Minn., Fla., La., Utah, Calif., Wash.
P. syrphi (Ashmead)	*Allograpta exotica* (Wied.)	Ill., N.C., S.C., Fla., La., Idaho, Calif.
	A. obliqua (Say)	
	Baccha clavata (Fab.)	
	Eupeodes volucris O. S.	
	Mesograpta polita (Say)	
	Paragus tibialis (Fall.)	
	Scaeva pyrastri (L.)	
	Sphaerophoria cylindrica (Say)	
	Metasyrphus nitens (Zett.)	
	S. opinator O. S.	
	S. rectus O. S.	
	S. ribesii (L.)	
Pteromalinae		
Eupteromalus dubius (Ashmead)	*Mesograpta polita* (Say)	D.C., Ohio, Ill., Iowa, Wis.
Chalcididae		
Chalcidinae		
Spilochalcis hirtifemora (Ashmead)	*Mesograpta polita* (Say)	D. C., N. C., Ga., Fla., Tenn., Ohio, Ill., Tex.
	Platycheirus sp.	
Figitidae		
Aspiceratinae—parasites in the puparia of Syrphidae. (No data are given by Muesebeck *et al.* on species of Syrphidae pupae from which these parasites have been recovered.)		
Paraspicera bakeri Kieffer		Wis., Ill., Md., D. C.
P. clarimontis (Kieffer)		Calif.
P. utahensis (Ashmead)		Utah.
Prosaspicera albihirta (Ashmead)		Fla.
P. similis (Ashmead)		Maine, N.H., Mass., N.Y., Conn., Pa., Ind., Ill., Mich., Wis., Idaho, Que.
Callaspidia provancheri Ashmead		Maine, N.H., Mass., N.Y., Conn., Pa., Ind., Ill., Mich., Wis., Idaho, Que.

TABLE 1—(Continued)

Parasite	Host	Distribution
Ceraphronidae		
Conostigmus ater Fouts.	syrphid puparium	Calif.
Conostigmus timberlakei Kamal	*Allograpta obliqua* (Say) *Sphaerophoria cylindrica* (Say)	Calif. (San Diego).
C. zaglouli Kamal	*Scaeva pyrastri* (L.) *Syrphus opinator* O. S.	Calif.
Diapriidae		
Diapriinae		
Diapria conica (Fab.)	*Eristalis tenax* (L.)	and Mich.; Kans.

Fungi

Certain entomogenous fungi are known to attack Syrphidae. Sweetman (1936) recorded that: "Perhaps *Empusa* is the most widely known of these fungi. *Empusa muscae* Cohn has long been known as a parasite of muscid, syrphid, and other flies appearing in the autumn as a halo-like mold enveloping the fly and ramifying throughout its tissues." Occasionally, this fungus kills large numbers of muscoid and calliphorid flies, but it is doubtful that it constitutes a serious threat to the Syrphidae under normal field conditions. *E. muscae* belongs to the class Phycomycetes ("algal fungi"), order Entomophthorales, family Entomophthoraceae (Empusaceae of some authors). Distribution is apparently throughout the temperate-tropical world. Most of the significant observations on the fungus have been made in the United States, Europe and South America.

BIRDS

Folsom (1922) recorded the English sparrow and the chickadee as important natural enemies of the aphid. Dudley (1924) reported on the beneficial work of red-winged blackbirds. Three birds were shot and their digestive systems examined; there were estimated to be 250 undigested pea lice to each bird. Dudley stated that other birds undoubtedly eat the aphids, besides those mentioned, and that it is conceivable that birds might also partake of any predator present at the same time, such as the larvae of Syrphidae, although there are no experimental facts to substantiate this.

Metcalf (1913) stated: "It seems probable that the adults of many species of Syrphidae are a considerable source of food for insectivorous animals of all kinds, especially birds and amphibians. The king-bird, phoebe and flicker are known to feed on *Eristalis tenax* (L.), but I am not able to give much detailed data on this point."

It is reasonable to assume that a wide variety of birds, including various wood peckers, sparrows, and flycatchers, feed upon syrphid imagos, or upon syrphid larvae and pupae, both the exposed, aphidophagous forms and the species which are found beneath bark, in decaying wood, in exuding sap of trees, and in semi-liquid media.

PLANTS

Metcalf (1913) further stated: "The common milkweed, *Asclepias* sp., is a rather formidable enemy of adult Syrphidae. When the latter visit these flowers, their legs are caught by the peculiar and well known pollinia of this plant. In collections one finds a good many specimens with these pollinia clinging to their legs. Large numbers of the weaker-bodied Syrphidae become permanently entrapped by the flowers, thus not only invalidating the remarkable specialization on the part of the flower, but resulting, after long and fruitless struggle, in the

death of the fly. So common is this entrapment that I found it well worthwhile, when collecting, to visit these flowers. I have found as high as twenty individuals entrapped on a single head." Numerous observations of the author substantiate these findings.

OTHER CAUSES OF MORTALITY

Undoubtedly, toads, lizards, spiders, and insects such as dragonflies, predaceous Hemiptera, and marauding ants, take a heavy toll on both adults and immature Syrphidae. Many more are killed by automobiles. Still others are trapped in houses and often may be found dead at the bases of windows. During the summer of 1950 the author took several specimens of small *Mesograpta marginata* (Say) trapped behind large picture windows high atop the Empire State Building, in New York City. Sieving devices, aphidozers, harvesters, and other machines used in cultivation and harvesting of crops, destroy large numbers of syrphid larvae. Dudley (1924) reported that in experimenting with an aphidozer to collect pea aphids from pea fields in Wisconsin, he collected with the aphids 1,523 syrphid fly larvae from two and one-half acres. Johnson (1900) recorded that in packing peas in southern Maryland, the separators sieved out in a few days about 25 bushels of larvae of Syrpidae, chiefly one species.

Because of the remarkable resemblance of many syrphids to Hymenoptera, there is a widespread misbelief that adult Syrphidae are stinging insects. Many of the smaller species frequently light on the hands or face of a field worker, apparently attracted by the salt deposits on the skin, and are ruthlessly killed by the worker, who believes them to be "sweat bees." Many times a farmer, seeing the small syrphid larvae on the foliage of his crop and believing them to be responsible for the wilting and spotting of the foliage, has sprayed with an insecticide, only to destroy the agents which have been checking the aphid responsible for the damage, and which in time, might have entirely controlled the aphid infestation.

Climatic factors play a primary part in determining the numbers of syrphids which develop and their longevity, but that subject is not within the scope of this paper.

CONCLUSIONS

Additional investigations are needed to determine the effect of modern insecticides upon Syrphidae. Beneficial activities of syrphids need greater recognition. Possibilities of introducing Syrphidae into new areas, or encouraging an increase of those already present, for the control of aphids and to supplement pollination of crops, needs further investigation, especially in relation to the cost of continued use of insecticides for aphid control.

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General Physiology. *Bradley T. Scheer.* John Wiley and Sons, Inc., New York. 1953. x+613 pp. $7.00.

General Physiology is an excellent example of a text written for a specific purpose by a teacher with a comprehension of his subject. This book is an integration of the fields of biochemistry and general physiology interwoven to interpret one in terms of the other. Many of the 1453 complete bibliographic references are current reviews of specific physiological problems.

Certainly this text was not written for students of physiology who lack chemistry training through physical chemistry if the students are to fully realize the derivations of equations, such as are given for free energy and entrophy.

This book is written in an unique and logical manner. Instead of the usual initial attack of the subject with a consideration of the chemical breakdown of protoplasm, the author discusses physiochemical aspects of life in a natural succession of topics beginning with energy, including nuclear energy and isotopic techniques, and ranging through the chemistry of cell constituents and physicochemical structure of cells.

The second part of the text is devoted to the sequence of chemical processes and interrelationships of enzyme systems, vitamins, and hormones. The catabolic and anabolic processes of fats, proteins, and carbohydrates are well diagrammed. In the last chapter of this section, the concepts of the first two parts of the book are developed to give a clear concept of the dynamic state of body constituents. Part III deals with energy manifestations and transformations in cells, organs, and organisms.

Lastly, the author considers the physiology of cellular fertilization, growth, and differentiation and of the integration of the organism by nervous and humoral intermediation. This volume is easy to read, well organized, and should prove to be of considerable value as a text for general physiology courses.

GEORGE F. SHAMBAUGH

NEW WESTERN DELTOCEPHALINE LEAFHOPPERS

DOROTHY J. KNULL

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Three *Psammotettix*, one *Sorhoanus* and allotypes of two *Orocastus* are described. Types are to be deposited in the Collection of The Ohio State University unless other deposition is mentioned.

I am grateful to Dr. David A. Young, Jr., of the U. S. National Museum for sending a paratype of *Psammotettix excavatus* (Oman) for The Ohio State University Collection, and for other assistance.

Orocastus aurarius Knull

Figure 6

Described from ♂s. ♀ cream-colored with dark arcs on face, arc either side of apex of head extending to black ocelli, eyes dark gray, a pair of median broad longitudinal stripes on pronotum faintly indicated, veins pale, clearly outlined with fuscous. ♀ segment as illustrated.

Length: 4 mm.

Allotype ♀, Davis Mts., Tex., Aug. 2, 1937, 2 specimens, Aug. 2, 1940; 1, Culberson Co., Tex., Aug. 29, 1940; 1, El Paso Co., Tex., Aug. 30, 1940; 5, Chiricahua Mts., Ar., Aug. 28, 1940, D. J. and J. N. Knull, Collectors.

Orocastus omani Knull

Figure 5

♀s similar in coloring and general appearance to those of *O. aurarius*, with dark markings sometimes more pronounced. Last ventral segment with median lobe broader, as illustrated.

Length: 4 mm.

From Arizona, collected by D. J. and J. N. Knull: allotype ♀ and 4 specimens. Types, Patagonia Mts., Aug. 7, 1950; 17, Aug. 20, 1940; 1 Tumacacori Mts., Aug. 21, 1940; I, Huachuca Mts., Aug. 19, 1950; 1, Tucson, Aug. 27, 1938.

Psammotettix dentatus n. sp.

Figures 12, 13

A long, slender, dark species, unique in dentation of aedeagus.

♂.—Ground color cream with tan markings. Vertex as long as pronotum, shorter than width between eyes, bluntly rectangular, with eyes a little broader than pronotum. Elytra greatly exceeding tip of abdomen.

Anterior margin of vertex with pair of oblique black dashes at apex and a dot just below and anterior to pale ocellus, a tan cloud either side on center of disk and a pair of dashes either side at base. Pronotum with six broad tan longitudinal stripes. Elytra hyaline with pale veins and some irregular darkening in cells, especially apical cells. Dorsum of abdomen black, venter black with yellow edges. Face dark brown with pale arcs and streak down middle; clypeus dark in middle, remainder pale.

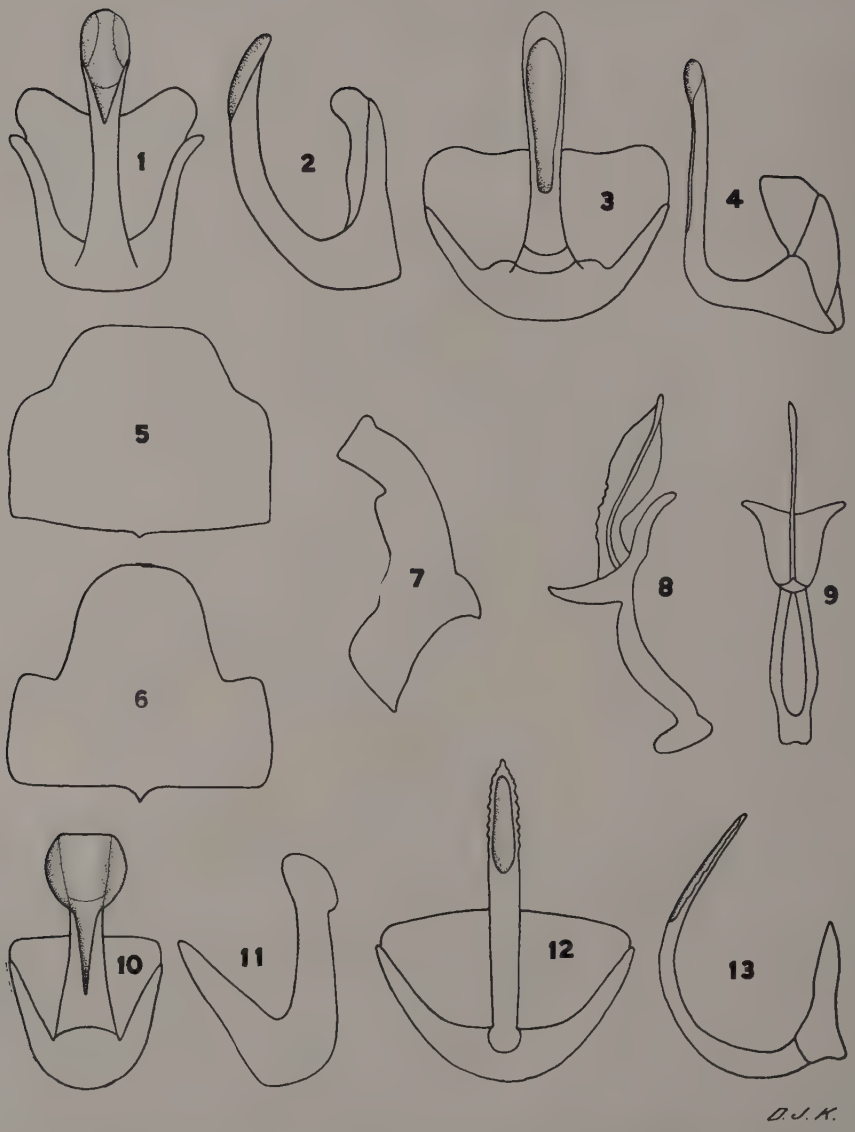
Valve large, more rounded than in other *Psammotettix*, exceeded by pale pointed plates by three-tenths of its length, base of aedeagus protruding distinctly beyond plates and pygofer. Aedeagus as figured with characteristic dentation.

♀.—Last ventral segment as long as preceding, slightly emarginate on median third.

Length: ♂ and ♀ 3.8 mm.

Taken in northern California by D. J. and J. N. Knull. ♂ holotype, allotype, 7 ♂ and 2 ♀ paratypes, Quincy, June 25, 1948; 1 ♂ and 1 ♀ Forest Glen, June 19, 1941; and Chester: 1 ♂ and 1 ♀, June 12, 1941; 1 ♂ and 4 ♀, June 23, 1948; 8 ♀, June 25, 1951; 3 ♀, July 1, 1951; 1 ♀, July 11, 1951.

In the long narrow form of aedeagus this species shows some affinity to *Psammotettix attenuens* (DeLong and Davidson).



1, 2. *Psammotettix revae* n. sp. Ventral and lateral view of aedeagus.
3, 4. *Psammotettix ferratus* (Del. & Dav.). Ventral and lateral view of aedeagus.
5. *Orocastus omani* Knull. ♀ last ventral segment.
6. *Orocastus aurarius* Knull. ♀ last ventral segment.
8, 9. *Sorhoanus fidus* n. sp. Style, lateral and ventral view of aedeagus.
10, 11. *Psammotettix obesus* n. sp. Ventral and lateral view of aedeagus.
12, 13. *Psammotettix dentatus* n. sp. Ventral and lateral view of aedeagus.

Psammotettix obesus n. sp.
Figures 10, 11

A strikingly marked, robust small species with stubby aedeagus.

♂.—Head shorter than space between eyes, as long as pronotum, bluntly angled, with eyes a little wider than pronotum. Ground color cream with the following brown markings: vertex, median small apical triangle with pale center, below apex on either side two broad, irregular, somewhat X-shaped spots, and at base a pair of narrow, elongate stripes, outer longer; eyes brown; pronotum with six broad longitudinal stripes; scutellum, a median spot; elytra mottled, cells across middle more embrowned forming very irregular saddle, apical cells and lower part of median anteapicals also dark; below, face dark with fine pale transverse arcs; dorsum and venter black with segments narrowly yellow-margined, showing some red toward lateral margins.

Valve large, characteristic of genus, exceeded by plates by two-thirds its length, plates joined half their length beyond valve then diverging sharply to triangular points, space between them forming an equilateral triangle; connectives of aedeagus and pygofer exceeding plates only slightly. Aedeagus illustrated.

♀.—Lighter in color throughout, but pattern distinct, sides of ovipositor dark. Last ventral segment a little longer than preceding, almost truncate, but with shallow excavation on median third and faint sinuation either side. A rounded translucent spot over base of ovipositor, surrounded by darkened area.

Length: ♂ and ♀ 3 mm.

♂ holotype, allotype, 2 ♂ paratypes, Grand Teton National Park, Wyoming, July 14, 1939, D. J. and J. N. Knull.

Psammotettix revae n. sp.
Figures 1, 2

Small, pale, robust species related in form of aedeagus to *Psammotettix cephalotes* (H.S.).

♂.—Head bluntly rectangular, as long as pronotum, not as long as width between eyes; ground color cream with light brown markings as follows: a pair of small triangles below apex, an arc below each black ocellus, a square spot behind each apical triangle and a pair of dashes either side of base; eyes gray brown; pronotum gray discally because of dark coloring underneath; scutellum pale. Elytra pale creamy subhyaline with sparse brown markings outlining some irregularly, scarcely covering tip of abdomen. Front brown with pale arcs and median strip, sutures black, venter and dorsum dark with sides broadly pale, and genital segments also pale. Valve and plates typical of genus, exceeded a little by base of aedeagus and pygofer.

♀.—Last ventral segment as long as preceding, parallel-margined, usually quite convex, which may make it appear excavated.

Length: ♂, 2.9 mm; ♀, 3.2 mm.

Described from a series of specimens taken in South Dakota by Dr. H. C. Severin. ♂ holotype, allotype, 12 ♂ and 33 ♀ paratypes, Reva Alkali Flats, Sept. 8, 1948; 14 ♂ and 24 ♀, Reva, Sept. 8, 1948; 2 ♂, Springfield, Sept. 13, 1948; and 1 ♂, Buffalo, Sept. 10, 1948. Paratypes sent to Dr. Severin.

Sorhoanus fidus n. sp.
Figures 7, 8, 9

Cream colored, sharp-headed, elytra with short apical cells, not quite covering tip of abdomen.

Head acutely rectangular, as long as width between eyes, longer than pronotum; face tan with light arcs, eyes dark brown, ocelli black, pronotum darker; elytra hyaline with golden veins, not quite covering pygofer. Dorsum dark to pygofer, venter light below thorax, darker in ♂.

Plates in ♂ narrowed on outer half to half basal width, with pointed, divergent apices, almost as long as pygofer. Inner genitalia illustrated. Last ventral segment in ♀ about twice as long at middle as preceding, incised almost half its depth, segment produced gently from sides, subtruncate, with small tooth either side of incision; median incised area including teeth covered by black pentagonal mark.

Length: ♂, 3.3 mm; ♀, 3.7 mm.

Holotype ♂ and allotype, Gillespie Co., Texas, May 7, 1946, collected by D. J. and J. N. Knull.

Dr. P. W. Oman upon examining these specimens placed the species near *S. orientalis* (DeLong and Davidson), however the sharply pointed head will distinguish it at once from most members of the genus.

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Gal. 26, Journal of Science, November, P-964

Plant Anatomy. *Katherine Esau.* John Wiley & Sons, Inc., New York. 1953. viii+735 pp. $9.00.

Miss Esau has achieved in this book the same high degree of excellence which characterizes her extensive research in the field of plant anatomy. The book is developmental in approach, sufficiently comprehensive in scope, accurate in most details, thoroughly documented, superbly illustrated and well written. The reader will find this book satisfying in that he will find answers to most of his questions, if the answers are known.

A good balance between topics has been achieved. The cell, cell types, tissue types, meristems, and the principal organs (except the hypocotyl) have been discussed separately in detail. Throughout the discussion of each, attention has been directed to its origin, and its significance with respect to the growth and attainment of form of the living plant. The physiological significance of the various structural phenomena are frequently called to the attention of the reader.

Some will say that the book contains too much material and too many details to be covered in a one quarter, or one semester course in plant anatomy. This is true—but this very fact makes the book more useful. This allows the instructor complete freedom to choose and to teach those topics which he believes to be most essential for his particular group of students. The book will serve as a broad and sound base upon which to construct a general course in plant anatomy which will serve the very real needs of the plant physiologist, horticulturalist, forester and entomologist. *Plant Anatomy* presents and elucidates the developmental and three-dimensional concepts of plant structure which every plant scientist must comprehend in order to completely and successfully relate the dogmas of his own special field to the growing plant. Miss Esau's book sets a new pace for plant anatomists and provides the means by which any plant anatomist may raise the level of understanding achieved by his students. *Plant Anatomy* has rendered the static, the cut-and-look, the paleobotanical, and the phylogenetic approaches to plant anatomy as archaic as a taxonomic approach to a general botany course.

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The Scientific Adventure. Essays in the History of Philosophy of Science. *Herbert Dingle.* Philosophical Library, Inc., New York. 1953. ix+372 pp. $6.00.

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THE SEASONAL BEHAVIOR OF THE JAPANESE BEETLE IN OHIO

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The study of the seasonal behavior of the Japanese beetle, *Popillia japonica* Newm., in Ohio began in 1942 in Cleveland, Youngstown, and North Salem. It was later extended to include the newer epidemic areas as they were found. Hawley (1944) reported that as the beetle moved north or south from the center of infestation in Philadelphia its habits and reactions have been found to change. Greater differences in behavior will probably be found as the infested area becomes larger. This paper is intended to show the behavior of the insect in Ohio in an average year and the differences in its behavior between different areas in the State.

During the 10-year period, from 1942 through 1951, population studies were conducted in 2 to 12 locations in the State each year. For example, in 1943, 2 areas were studied, 1 in Cuyahoga County and 1 in Guernsey County. In 1951, 12 locations were studied, 4 in Cuyahoga County, 1 in Lake County, 1 in Trumbull County, 1 in Columbiana County, 2 in Jefferson County, 1 in Guernsey County, and 2 in Washington County. The number of locations surveyed changed from year to year due to the flunctuation in the soil population in the area selected for study thus making it necessary to discontinue the study in some areas before new ones were found. Also, in some years the study had to be changed in order to have it fit in with the overall Japanese beetle research program.

The soil population was determined by examining soil samples and noting the number of individuals of each stage present. Each sample in the various locations consisted of (a) 100 specimens or (b) the number of specimens found in ten one-third square foot cores of soil. The samples were taken at weekly intervals.

The data for the years from 1942 through 1951 have been compiled and averaged in table 1 by 7-day intervals from April 2 to October 14 in order to determine the approximate distribution of the various stages of the insect in an average year. A wide variation was obtained in the behavior of the insect during the 10-year period, but as years with ideal conditions for the development of the insect offset those with unfavorable ones, the data presented in table 1 show what can be expected in an average year.

The data in table 1 show that a few third instar larvae of the previous year's overwintering brood were found in the soil as late as October 14. This condition was especially common in the Cleveland area in 1943 and 1944 when there was scant rainfall throughout the two summers. The soil was very dry early in the spring and summer of both years. This was responsible, undoubtedly, for the delay in the transformation of the larvae. In this and other areas a delay has been caused also by the larvae becoming infected with the spores of the milky disease supposedly late in May or early June. When this happens the transformation is or seems to be delayed as much as a month or more without the usual death and decay of larvae especially during seasons with a low rainfall.

These data show also that on October 8 to 14 eighty-seven percent of the larvae were in the third instar, eleven percent in the second instar, and less than one percent in the first instar. On April 2 to 8 of the following year ninety-two percent were in the third instar and approximately eight percent in the second instar. In the spring of 1951 a few first instar larvae were found in the Cleveland area during the period April 30 to May 6 and again during May 14 to 20. The survival of first instar larvae may have been due to the mild weather that prevailed during the

winter of 1950–51. Throughout the whole winter period there was a heavy snow cover with very little frost in the ground. These data would indicate that some first instar larvae can survive the winter under such conditions.

During the course of this study some deviation occurred from year to year in the seasonal cycle from that shown in table 1. For example, in 1941 and 1942, ninety-seven percent of the larvae overwintered in the third instar, while in 1943 and 1944 and again in 1950, the percent of third instar larvae going through the winter period varied from 60 to 79 percent in the different locations.

TABLE 1

The average percent of the various stages of the Japanese beetle in the soil in the different locations for the period from 1942 through 1951.

Date of Examinations	Number of Specimens Observed	Overwintering Instars			Pupae	Adults	Eggs	Instars		
		1	2	3				1	2	3
Apr. 2– 8	257		7.7	92.3						
9–15	583		8.1	91.9						
16–22	705		10.6	89.4						
23–29	1387		8.7	91.3						
Apr. 30–May 6	2132	0.3	12.8	86.9						
May 7–13	2115		15.6	84.4						
14–20	3083	0.3	14.3	85.4						
21–27	3332		11.7	88.3						
May 28–June 3	3322		5.1	94.5	0.4					
June 4–10	4876		7.0	88.0	4.7	0.3				
11–17	3472		1.2	79.1	19.3	0.4				
18–24	3438		1.1	51.6	42.2	5.1				
June 25–July 1	2474		0.1	31.8	42.0	20.5	5.6			
July 2– 8	2039			24.3	25.5	31.5	18.5	0.2		
9–15	2172			9.8	8.6	11.7	59.7	9.2	1.0	
16–22	2372			4.3	4.3	3.2	66.4	19.5	2.2	0.1
23–29	2202			2.5	3.6	4.0	55.9	31.4	2.5	
July 30–Aug. 5	2027			3.8	2.5	3.8	34.0	50.5	5.2	0.2
Aug. 6–12	2319			1.7	0.8	2.2	22.6	56.0	15.8	0.9
13–19	1691			2.0	0.2	0.8	13.4	45.7	36.8	1.1
20–26	2101			1.4		0.9	8.7	35.4	45.2	8.4
Aug. 27–Sept.2	1636			0.6		0.1	7.9	19.1	49.1	23.2
Sept. 3– 9	1328			1.2			3.0	9.6	31.7	54.5
10–16	1296			1.2			0.5	10.7	27.9	59.7
17–23	1593			0.8			1.7	3.5	19.5	74.6
24–30	495			1.4		0.2	2.6	6.5	23.2	66.1
Oct. 1– 7	714			0.3				1.3	11.8	86.7
8–14	535			0.7			0.4	0.6	11.2	87.1

In order to determine whether the seasonal behavior of Japanese beetle stages in the soil varies in the different areas in Ohio, the State was divided into three sections later referred to as the southern, central and northern areas. The southern area falls between 39° and 40° north latitude, the central area between 40° and 41°, and the northern area between 41° and 42°. The data collected in the various areas on the seasonal cycle of the insect were compiled and averaged for the purpose of comparing the behavior of the species in the different sections.

From the data in table 2 it can be seen that the pupae appear about 10 days earlier in the southern area than in the central section and 14 days earlier than in the northern section. The difference is only 6 and 9 days in the adult stage, 0 to 6 days in the egg stage, 2 to 3 days in the first instar larvae, and no

difference to a slight reversal in development in the second and third instar larvae in the northern area. Based upon "Hopkins bioclimatic law" the appearance of the various stages in the southern section should have been approximately 8 days earlier than in the central and northern areas. No difference should be found between the central and northern sections because the greater elevation in central Ohio would tend to compensate for the difference in latitude. The data presented here agree with the law fairly closely during the fore part of the year but there seems to be some deviation from the expected result in the latter part of the year.

During the period from 1942 through 1951, traps were operated near each of the soil population study sites in order to obtain more information regarding the behavior of the adults during the summer. Ten traps were used in each location and the number of locations varied from three to eleven in the State each year.

TABLE 2

Comparison of the average time of appearance of the various stages of the Japanese beetle in the soil in the southern, central, and northern areas in Ohio.

Area	Average Time of Appearance of					
	Pupa	Adult	Egg	Instar		
				1	2	3
Southern	5–30	6–20	7–3	7–19	8– 2	8–23
Central	6– 9	6–26	7–2	7–21	8–15	8–27
Northern	6–13	6–29	7–9	7–22	8– 1	8–18

TABLE 3

The average time of appearance of the first beetle taken in traps and the average peak of beetle flight in the southern, central, and northern areas in Ohio.

Area	Time of Appearance of First Beetle	Greatest Number of Beetles Taken During Week Ending	50 Percent of Total Catch Reached Week Ending
Southern	6–23	7–17	7–21
Central	6–25	7–24	7–25
Northern	6–25	7–26	7–26

All traps were set out during the first week in June and removed during the second week in September. The traps were checked once a week during the summer except for the period from June 15 to 30 when they were checked daily for the purpose of determining the time the first beetle was taken in the traps.

Results of these studies were summarized and averaged in table 3 to show the average time of the first appearance of the adult in the traps and the average time the peak of beetle flight occurred in the three different areas in the State. The peak of beetle flight was determined in two different ways. By the first method, the peak was based upon the time the greatest number of beetles were taken in traps for any one week and by the second method it was based upon the time at which 50 percent of the total catch was taken. The data in table 3 were compiled for the 10-year period by averaging the times of appearance of the first beetle taken in the traps and also the time of the peak of beetle flight.

These data show that in an average year the beetles appear first in southern Ohio. However, the difference between the southern section and the central and

northern sections amounts to only 2 days. Slightly greater differences occur between the sections in regards to the peak of beetle flight. When the peak is based upon the greatest number of beetles taken in any one week, the difference amounts to 7 days between southern and central sections, 9 days between the southern and northern sections, and only 2 days between the central and northern areas. When the peak is based upon 50 percent of the total catch, the difference between the southern area and the central area is only 4 days, between the southern and northern sections 5 days, and only 1 day between the central and northern sections.

The first appearance of beetles in traps varied from June 17 to 28 in the southern section, from June 17 to July 5 in the central area, and from June 19 to July 3 in the northern section. The peak of beetle flight based upon the greatest number obtained in any one week varied from July 16 to August 6 in the southern section, from July 4 to August 11 in the central section, and from July 5 to August 14 in the northern section. When the peak of beetle flight was based upon 50 percent of total number taken, the peak varied from July 15 to August 3 in the southern section, from July 4 to August 6 in the central section, and from July 9 to August 12 in the northern section.

In summarizing the results of this study, the data indicate (1) that there are usually a few third instar larvae that are delayed in development and found present in the succeeding generation, (2) the seasonal development of the insect begins earlier in southern than in northern Ohio as shown by the earlier pupation and emergence, (3) development of the first, second, and third instar larvae proceeds at a more rapid rate in northern Ohio than in southern Ohio as shown by the average time of the first appearance of the various instars, and (4) the beetles appear and attain the peak of flight a few days earlier in the southern area than they do in the northern.

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Methods and Principles of Systematic Zoology. *Ernst Mayr, E. Gorton Linsley* and *Robert L. Usinger.* McGraw-Hill Book Company, Inc., New York. 1953. ix+328 pp. $6.50.

Publication of this long needed book fills a vacancy in the zoological literature. The basic principles of classification and identification of animals are thoroughly covered along with an extensive discussion concerning the criteria for establishing the species as a taxonomic category and the principle types of evidence that should be used in setting up each of the various classification categories. Details concerning the evaluation of the many characters available to the taxonomist for discrimination between species and subspecies are stressed in several chapters.

A chapter on quantitative methods of analysis brings out the importance of the use of statistical methods to the taxonomist who is concerned with differentiating species and populations by a more precise method. One of the important features of this excellent book is the chapter on presentation of findings and its sequel, the one on the preparation of taxonomic papers for publication. Many valuable hints and suggestions are offered by which even the experienced writer may be helped. Although the authors state repeatedly that they do not favor regimentation in the methods of procedures of taxonomy they do seem to favor an accepted form for taxonomic articles, an idea generally approved by zoologists.

The final section of the book contains clarifications and explanations of the many rules and opinions of the International Zoological Congresses and the International Commission on Zoological Nomenclature. A chapter is devoted to the principle of priority and its many problems. The rules concerning the designation of the various taxonomic categories from species to phyla are presented along with examples illustrating the correct methods of interpreting the regulations.

JOHN E. LANE

ENROLL A NEW MEMBER

The Ohio Academy of Science was organized on December 31, 1891, at Columbus, was incorporated on March 12, 1892, and became affiliated with the American Association for the Advancement of Science early in 1920. Its membership has grown from 59 charter members to more than 1200. The membership is representative of the educational and scientific institutions of the State and includes quite a number of persons outside the State.

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SECTIONS—Each member is enrolled in *one* section for voting purposes, but is privileged to participate in the program of any section. To avoid excessive subdivision into sections as new fields of research develop, symposia which may cut across several fields of interest are scheduled at the annual meeting at hours which permit attendance of persons from various sections. Sections are listed below.

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B—Botany	F—Physics & Astronomy	J —Science Education
C—Geology	G—Geography	K—Anthropology & Sociology
D—Medical Sciences	H—Chemistry	L—Conservation

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RESEARCH FUND—From 1898 to 1922, through the generosity of M. Emerson MacMillan, of New York, a fund was available annually for encouragement of research among the Academy members. An accumulation from this grant together with the annual grant from the A.A.A.S. makes grants for research available to Academy members. This fund is administered by a committee known as the Trustees of the Research Fund.

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